CIVIL ENGINEERING

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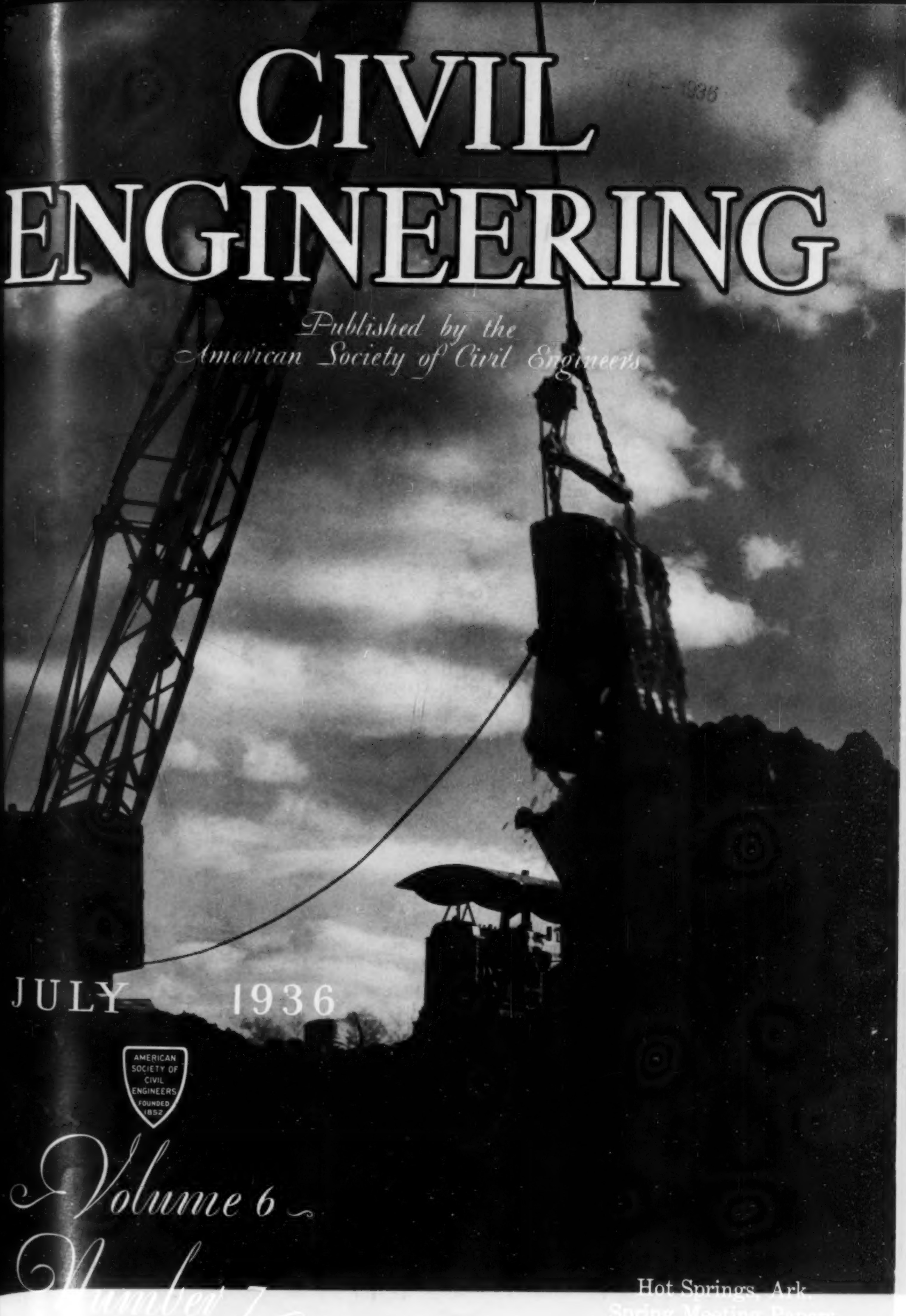

JULY 1936

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

Volume 6

Number 7

Hot Springs, Ark.
Spring Meeting Papers

Among Our Writers

Orville E. Walsh became assistant to the Kansas City district engineer in 1931. In 1933 he was promoted to be district engineer. Since 1935 Captain Walsh has been assistant to the division engineer, Missouri River Division.

Harvey C. Couch, a native of Arkansas, has been active in public utility operations for many years. He organized the Arkansas, Louisiana, and Mississippi power and light companies, and served as a member of the Reconstruction Finance Corporation until September 1934.

L. W. Baldwin rose through various engineering and operating grades to become vice-president and general manager of the Central of Georgia Railroad, a subsidiary of the Illinois Central, prior to the World War. Since 1923 he has been president of the Missouri Pacific.

Grover T. Owens has practiced law for 25 years. He is now serving as president of the Little Rock Chamber of Commerce, which, in cooperation with other business groups, aims to bring about legislation that will ensure adequate flood control of nearby rivers.

T. H. Barton, a pioneer in the Arkansas oil industry, organized the Natural Gas and Fuel Corporation in El Dorado a few months after the first well was brought in. Since 1929, he has been president of the Lion Oil Refining Company.

Earle W. Hodges served from 1911 to 1917 as secretary of state of Arkansas and has also acted as secretary of the Arkansas Press Association. He is now public relations counsel with the Cities Service Company of New York.

Gerard H. Matthes has made the cut-off and dredging program of improvement for the Mississippi River his chief problem since 1930. He has also served of late years as a flood consultant for TVA, and as water consultant for the National Resources Committee.

N. F. Helmers entered the contracting field in 1910. Since 1915 he has been associated with the Siems' interests of St. Paul, specializing in heavy bridge foundation work. He served as president of the Associated General Contractors in 1934 and 1935.

J. A. LePrince was in charge of field sanitation in the Panama Canal Zone from 1904 to 1914, during construction of the canal. Since 1914 he has been engaged in malaria control investigational studies for the U. S. Public Health Service.

Charles B. Burdick has specialized in water supply, flood relief, and water and sewage purification work for over 40 years. He is co-author of the book *Relief from Floods* (1918) and has written numerous technical papers.

E. L. Filby has served as state sanitary engineer for the South Carolina Board of Health and as chief engineer for the Florida Board of Health. Since 1931 he has been principal assistant engineer with Black and Veatch.

Rufus W. Putnam, former lieutenant colonel, U. S. Corps of Engineers, served as Chicago district engineer from 1918 to 1926. Later he became chief engineer for the Harbor Plan of Chicago. He is now president of the Maritime Engineering Corporation.

S. L. Wonson specialized in bridge design and construction with the American Bridge Company, Mexican Railway, and Missouri Pacific Railroad (beginning in 1910). As assistant chief engineer of the latter road, he is active on railroad committees on waterways and flood control.

T. B. Larkin, after service with the U. S. Corps of Engineers in Mexico and France, was appointed district engineer of the Vicksburg District in 1930. In November 1933, he was placed in charge of the Fort Peck project.

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CIVIL ENGINEERING

JULY 1936

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NUMBER 7

Taming the Missouri River

Army Engineers Are Rapidly Bringing the "Big Muddy" Under Control with Dikes and Revetment

By ORVILLE E. WALSH
CAPTAIN, CORPS OF ENGINEERS, U. S. ARMY, ASSISTANT TO THE DIVISION ENGINEER, MISSOURI RIVER DIVISION, KANSAS CITY, MO.

ONLY a few years ago the Missouri was a wild stream whose tortuous bends, shoal crossings, and shifting channels defied navigation. But today a barge line operates on dependable schedule as far upstream as Kansas City, and within a few years the service will be extended to Sioux City. The Army Engineers who are making it possible are justly proud of their work. The reshaping of a river, says Captain Walsh, is more an art than a science. It is a problem that yields not to mathematical analyses, but to long years of experience and experiment with the river itself. Incidentally, this experience has shown the futility of "fighting" the river—the art of taming it consists largely in putting it to work cutting its own channel and building its own banks. The present article is abstracted from a paper presented on April 23, 1936, before the Waterways Division at the Society's Hot Springs Meeting.

WORK on improving the Missouri River for navigation has been in progress for just 100 years, the first appropriation for snagging having been made in 1836. Spasmodic work—principally snagging, revetting of caving banks in the vicinity of cities and villages, and experimental construction—was carried on from that date until 1928. In the latter year a comprehensive plan, with adequate appropriations to carry it forward, was placed under way, and since then active operations on a large scale have been in progress.

The existing project, which includes the river from Sioux City, Iowa, to its mouth (approximately 800 river miles), provides for securing a permanent navigable channel with a minimum low-water depth of 6 ft and a minimum width of 200 ft, with reasonable additional width around bends. On completion of the Fort Peck Dam and the release of stored water to increase the minimum discharge, navigable depths of from 8 to 10 ft will be obtained.

Formed by the junction of the Jefferson, Madison, and Gallatin rivers in southwestern Montana, the Missouri River flows in a general southeasterly direction to its confluence with the Mississippi, about 15 miles above St. Louis. It has a length of about 2,470 miles, a drainage area of approximately 529,000 sq miles, and a total fall of about 3,630 ft. From Yankton, S.Dak., to the mouth, a distance by river of about 890 miles, it flows mostly through rolling plains, and its bed and banks are extremely unstable.

The mean low-water discharge varies from about 8,000 cu ft per sec at Sioux City to about 20,000 cu ft per sec at the mouth, and the record low-water discharge during the navigation season at Kansas City, which is about the center of the project, is 9,300 cu ft per sec. The mean high-water discharges at Sioux City and the mouth are about 120,000 and 260,000 cu ft per sec, respectively. The part of the river under improvement varies in width at bank-full stage from a minimum of about 800 ft to a maximum of about 7,500; the average is about 3,200. The height of bank above the mean low-water line varies considerably—in the section from Kansas City to the mouth it averages 16 to 20 ft; and between Kansas City and Sioux City, from 10 to 12 ft.

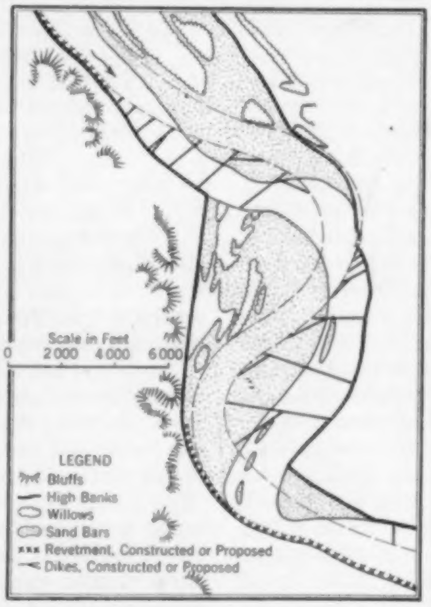


FIG. 1. IMPROVEMENT LAYOUT FOR A TYPICAL SINUOUS PORTION OF THE MISSOURI RIVER

The Missouri River is one of the heaviest silt-bearing streams in the world. At Kansas City its average sediment content is about 5,000 ppm, and at certain points the sediment content at times may be as great as 25,000 ppm. Although in some places it makes dredging necessary, this heavy silt content is generally an aid in our work, as it causes prompt filling behind dikes.

THE MISSOURI IS AN ERRATIC STREAM

In its natural state the Missouri is a "wild" river. It is frequently difficult to distinguish in it the definite bends, crossings, and reaches characteristic of most rivers. During periods of low water it wanders between the high banks in numerous small streams among continually shifting sand bars. The high banks themselves are not stable, as they are readily eroded when subjected to

direct attack. Study of a 200-mile unimproved section has shown that an average of 43 acres of good tillable land per mile is lost by erosion each year.

The problem of improving the Missouri for navigation has been to give this shapeless, unstable river the general characteristics of more temperate streams with fixed beds—to make a single good channel out of many poor ones, contract the low-water channel to suitable width, shape it into bends of proper curvature and length, and direct the water in a concentrated flow at the crossings. The methods now used in this work have developed through many years of experimentation. The two major types of structures are permeable pile dikes and revetments—dikes to contract and shape the river, and revetments to hold it in place.

Dikes are openwork structures of piles, driven into the river bed and braced and lashed together. Their riverward ends are so located as to give to the channel the desired shape and location. As the dikes are permeable they do not completely obstruct the flow of water, but they so retard it that much of the sediment load is dropped on their downstream side. This deposit is built up with each high water, and eventually the entire dike is buried. How rapidly the filling may take place is shown in the accompanying group of illustrations.

ENGINEERS DRIVE THE DIKES AND THE RIVER DOES THE REST

When the Upper Picture Was Taken, Water Was Flowing 15 to 20 Ft Deep Through Most of the Dikes. The Middle View Shows the Conditions a Bare Five Months Later, and the Lower View the Results Attained in Less Than Two Years

In addition to causing a fill, dikes create a head that tends to warp the surface of the river. A dike normal to the direction of flow creates the greatest warping effect and tends to cause the river to flow to the opposite bank. By increasing the angle of inclination, the warping is decreased. Proper direction can thus be given to the flow.

Revetment consists of a woven willow or lumber mattress, built along the shore and sunk by ballast to the bottom of the river. This mat prevents under-water scour and is of such width that it will extend about 30 to 50 ft beyond the under-water toe of the bank slope. Above the mattress the bank is graded and paved with riprap. The revetment holds the bank opposite a dike system and makes it possible to give the bank the proper curvature after the dikes have caused erosion.

GENERAL REQUIREMENTS OF A SATISFACTORY CHANNEL

Efforts have been made to set up definite formulas to determine the proper curvature, width, and depth for the improved channel under given conditions of slope, discharge, and so forth; but because of the many indeterminate variables involved it has not been possible to develop them. Hence layout work on the Missouri River is more an art than a science, and is based upon observation of what has proved successful in the past.

Experience has shown that the low-water channel will usually maintain itself, in a bend between Kansas City and the mouth, provided the radius of the bend does not exceed 10,000 ft and is greater than 4,000 ft. As we ascend the river we find that the maximum permissible radius decreases; at Sioux City, Iowa, it is about 7,000 ft. In other words the maximum permissible radius becomes shorter as the low-water flow decreases.

Bends exceeding $3^1/_2$ miles in length in the upper section and 5 miles in the lower section are usually unsatisfactory. Radii of less than 4,000 ft are not desirable because of the eddies formed by the sharp change in direction, and because during high stages bars are likely to form where the current flowing around the outside of the bend intercepts the flow across the point.

The ideal bend is one having a decreasing radius from head to foot. Where it is practicable to erode a bend to the desired curvature, the dike system is laid out so as to effect the desired result, and the bank is promptly revetted when it has been obtained.

By observation at numerous critical and reasonably stable points, it has been determined that a clear channel width of from 700 to 1,500 ft is required for high-water discharges if the velocities and stages obtaining under natural conditions are not to be increased.

Suppose that a layout is to be prepared for an entirely unimproved section of river. The first requisite is a good map, showing existing bank lines, islands, bars, chutes for both low and high water, and the elevation of all important points. The scale we use is 1 in. to 400 ft. This map is studied carefully, particular attention being given to the location of unusually high banks and to the various "stable points" in the section—bluff contacts, tough gumbo banks that have long resisted erosion, and banks that have been held by the works of man. High- and low-water profiles are also observed.

A reconnaissance trip is then made over the river and the main thalweg is plotted on the map so that the

present tendency of the river may be ascertained. All the features particularly noted in our previous map study are observed carefully; places in which erosion and deposition are taking place are marked; and tentative locations for the improved channel are sketched in.

These locations are then carefully laid out in the office. The bends are given decreasing radii throughout their length, and proper widths for the channel are selected. A check is made to see whether the tentative locations will materially disturb the natural slope of the section; or, if the natural slope is not normal, whether they will improve it. The locations are then compared, and the dikes and revetment required to establish the one that appears to be best are tentatively laid out. Such a layout is shown in Fig. 1. If a second location appears to be almost equally advantageous, the cost and difficulties of constructing the two are compared.

The selected layout is then turned over to a survey party so that profiles along dike and revetment lines can be run and probings made where necessary. From these data the required type and strength of each dike in the system can be determined.

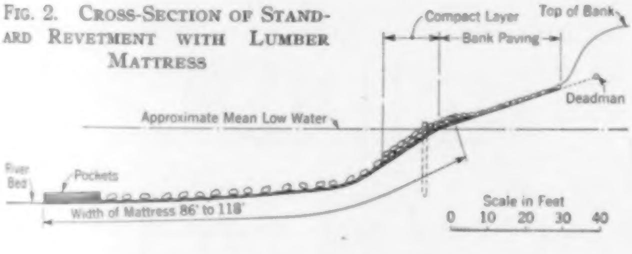
When the approved layout has been staked in the field, construction is started. Up-to-date information on the effects of the work is provided by frequent hydrographic surveys, and the layout is modified whenever the changing conditions indicate it is desirable to do so.

STABILIZATION STRUCTURES ARE NOW STANDARDIZED

Many different kinds of structures for stabilizing the river, moving it to a new locality, and preventing erosion have been tried in the past. Among them may be mentioned the Brownlow weed, retards, jetties of various types, bank heads, frame dikes of both concrete and timber, clump dikes, and various types of revetment. The structures now regularly employed include standard revetment and pile revetment, permeable pile clump dikes, braced dikes, batter pile dikes, and abatis.

Standard revetment (Fig. 2) consists of a subaqueous woven mattress of willow or lumber, 86 ft in width, and an upper-bank paving of riprap. The lumber mattress is made by weaving 1 by 4-in. boards, spaced 8 in. on centers, over and under boards of a similar size ("weavers") spaced 4 ft on centers. The entire mattress is

FIG. 2. CROSS-SECTION OF STANDARD REVETMENT WITH LUMBER MATTRESS



strengthened in both directions by additional 1 by 4-in. boards. The willow mattress is woven with a regular basket weave, and is approximately 1 ft thick. It is reinforced in both directions by $^3/_8$-in. galvanized strand, drawn tight and held in position by cable clamps.

The landward edge of the mattress is placed as low on the bank as possible—seldom more than 3 ft above the mean low-water line. The bank above the low-water line is graded either hydraulically or by dragline on a 3 to 1 slope and paved with one-man stone averaging 75 lb per stone. To secure a satisfactory bond between paving and mattress, and to afford additional protection to the weak section where the mattress is alternately dry and wet, a compact 1-ft layer of stone is cast in, extending $11^1/_2$ ft channelward of the mean low-water line.

In grading the bank for revetment, all points are leveled so that a smooth and continuous curve is obtained. Snags and other obstructions that would create bad eddies or prevent the mattress from resting on the bottom of the river are removed. The lumber mattress is ballasted with one-man stone, 0.6 cu yd being

A THREE-ROW CLUMP DIKE UNDER CONSTRUCTION
The Lumber Mattress, Later to Be Ballasted and Sunk, Is Designed to Protect the Dike from Scour

used per "square" (100 sq ft). For the willow mattress 1 cu yd per square is required.

Pile revetment is similar to standard revetment except that a 2- or 3-row longitudinal pile dike is substituted for the bank paving. It is driven so as to form a smooth curve and is located approximately on the intersection of the mean low-water plane with the bank.

Permeable pile clump dikes (Fig. 3) have four main features—the dike proper, the foundation mattress, the dike root, and the terminal. The dike proper consists of two or more rows of three-pile clumps. Each clump is driven as a tripod, the top being tightly cabled with 7 turns of $^3/_8$-in. galvanized strand. Where the adjacent banks are high, the dike is usually built to an elevation about 2 ft below the top of the bank; if low banks prevail, the dike is built to an elevation of from 12 to 14 ft above mean low water and extended back until a high bank is reached.

In the two-row dike the clumps of each row are usually spaced 15 ft on centers; in the three-row dike the normal spacing is 18 ft. The clumps of the first and third rows are in line; those of the second row are spaced halfway between. The spacing of the rows is such that a continuous pile stringer may be driven in with the pile hammer and lashed securely to one pile of each clump in adjacent rows. The stringers are made continuous with a lap of at least 6 ft, the lap occurring in every case at the contact of the stringer with a pile clump. When the dike is subjected to strong attack, the three-row structure is used and the piles are driven to a penetration 30 ft below the foundation mattress. When the attack is not strong, a two-row dike is usually used and a penetration of 20 ft has been found to be adequate.

The foundation mattress, of either willow or lumber, is similar to that used for revetment. It is approximately 77 ft in width and extends the full length of the dike, 28 ft upstream and 49 ft downstream from the center line of the dike. Where the dike is subject to a strong attack, additional ballast stone is thrown in along the dike line, $^1/_2$ cu yd per lin ft of dike being used.

The root of the dike serves to prevent flanking. A 104-ft section of bank at the landward end of the dike is revetted, and the mattress of this revetment is extended

to form the dike-foundation mattress. A single row of piles spaced 6 ft on centers and staggered so that a stringer may be placed between them is carried from the last clump of the upstream row as far back on the bank as is possible while still maintaining the elevation of the dike. To resist scour, a rubble wall is built beneath the stringer, 1 ft high and 2 ft thick.

The terminal is a heavy group of clumps driven at the outer end of the dike to protect it from unraveling as the result of scour or attack by ice. The terminal usually consists of 36 piles made up of 12 clumps securely bound into a solid mass with cables, and further strengthened by the addition of 100 to 150 cu yd of ballast stone.

When the possible penetration is between 8 and 20 ft, an extra row of clumps is usually driven 30 ft downstream from the main dike. Piles running diagonally from the bottom of the clumps of the additional row to the top of piles in the downstream row of the dike proper provide the necessary bracing.

A batter pile dike occasionally is used in very shallow water or on a low, dry sand bar. It consists of a series of bents similar to those used in a bridge; each bent consists of four piles driven with a slight batter. The bents are spaced 15 ft on centers and are braced both longitudinally and transversely.

When rock bottom is encountered or practically no penetration can be obtained, crib dikes are used. These cribs are of timber, approximately 20 by 30 ft in plan, and are ballasted with sufficient stone to give them stability without destroying their permeability. They are anchored by cables to deadmen placed on shore and well upstream from the dike line. If they do not rest on a rock bottom, a willow foundation mattress is provided.

In places where there is flow only at high stages—such as on high bars or on low banks at the landward end of a dike, abatis are often used. An abatis consists of a ballasted foundation mattress of willows, 20 ft in width, covered with hog wire and surmounted by a braced fence-like structure. The fence is also covered with a hog-wire netting to catch drift and thus reduce its permeability and increase its tendency to cause a fill.

Strange as it may seem at first thought, reaches often present as many difficulties as bends. In long reaches the river tends to meander during periods of low water, and it is difficult to maintain navigable depths on the numerous crossings that are formed. In some cases the construction of low dikes, with an elevation about 6 ft above mean low water, has been effective in keeping the river in a single channel along one side of the reach. These low dikes are usually built as an extension to, and about 300 ft beyond, the end of high dikes. The amount of over-contraction that is permissible is dependent upon conditions existing in each case. If both banks are low, a comparatively large amount of over-contraction is safe. If one bank is low and the other high, moderate over-contraction is permissible. If both banks are high, over-contraction becomes dangerous to the dike system, for the necessary channel capacity for high water cannot be obtained by over-bank flow and it is consequently secured by scour.

DREDGES SUPPLEMENT THE WORK OF THE DIKES

Even when all these works to stabilize and regulate the river have been installed, there still remain some crossings which from time to time do not have suitable depths. If given time, many shoal crossings will erode unassisted and provide navigable depths, but the use of dredges is essential to open them promptly and to care for those that cannot scour themselves.

At present there are five dredges assigned to the Missouri River, four of which were especially designed for use on that stream. They are hydraulic dredges of the dustpan type, with discharge lines 34 in. in diameter. The head is 36 ft wide. The pump impeller is 82 in. in diameter and is direct-connected to a vertical triple expansion reciprocating condensing engine of 1,250 hp, which operates at 160 rpm. The dredges have a design capacity of 3,000 cu yd per hr and in operation have consistently exceeded this figure. The best record so far was the removal of 156,000 cu yd in 24 hr.

Before dredging is undertaken a survey of the crossing is made, extending into the pools above and below. Navigation difficulties, a knowledge of the past history of the crossings, the apparent tendency as shown by the hydrographic survey, and the probable future trend in river stages, are all considered in laying out the channel to be cut. Usually the selected course is not the shortest distance between the pools, but the one which is considered to be the most stable and easily navigable.

Our experience has shown that the best results are obtained by dredging with the head down about 18 ft and keeping the dredge pulled up hard in the cut. This method requires the removal of a greater yardage than dredging at a lesser depth, but accomplishes the desired result with fewer cuts, and as deep cuts take essentially no more time to execute than shallow ones the deep dredging actually results in economy of both time and money.

In 1931 the low-water flow at Kansas City dropped to 10,700 cu ft per sec during the navigation season—approximately half of the previous navigation-season minimum in a 75-year period of record. It became apparent that provision must be made to furnish additional water during periods of drought if a continuously navigable waterway of 6 ft depth was to be provided. Consideration of various reservoir sites resulted in the selection of the Fort Peck Reservoir as the most satisfactory for the purpose. Construction was authorized in the fall of 1933 as a part of the public works program, and is now actively under way.

Improvement of the river from Kansas City to the mouth was essentially completed by the end of 1934, and the Federal Barge Lines started operations between St. Louis and Kansas City in June of 1935. During the navigation season they have operated on a weekly schedule, and have experienced only minor delays in spite of the fact that the discharge at Kansas City dropped to approximately 15,000 cu ft per sec in the fall of 1935 and remained at that point for almost a month. The new barge service has given shippers and consumers along the river the advantages of decreased freight rates to and from many points in the East and Southeast.

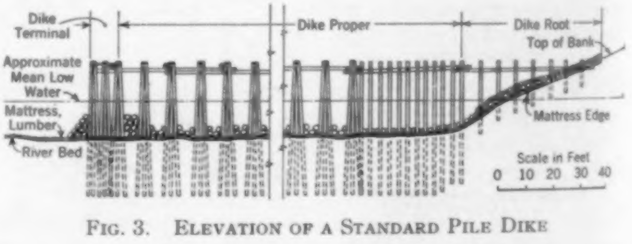


FIG. 3. ELEVATION OF A STANDARD PILE DIKE

The works for navigation have had the incidental result of preventing the erosion of good agricultural land, and have therefore been of tremendous value to property owners in the alluvial valley. Moreover, as the work has been carried on most actively during the past few years, it has been a real factor in providing relief employment throughout the entire Missouri Valley.

Engineers Active in the Mid-South

Importance of the Engineering Services Recognized in Lower Mississippi Basin

FLOOD control and transportation problems have aroused widespread concern in the lower Mississippi Valley. But progress is being made toward satisfactory solutions, and the importance of the engineer in this connection is becoming more and more evident. Meanwhile the Mid-South continues to grow industrially and agriculturally. Its resources are only beginning to be developed. Accounts of these various matters were presented in a symposium held April 22, 1936, at the Hot Springs meeting of the Society. Each of the five papers delivered at that time is here abstracted for the information of members.

To Mr. Couch the Mississippi basin is the land of present accomplishment and future potentiality. He reviews its development and points particularly to the great industrial and agricultural advances of recent years to prove his thesis that it "stands on the threshold of a new era of living."

A similar viewpoint is developed by Mr. Baldwin as regards the railroads of this area. In spite of handicaps—such as the depression, unfair competition, drastic regulation that does not apply equally to other transportation agencies, and loss of business to government-endowed barge lines—he is certain that the future of the railroads is secure.

Objections to the present Mississippi flood-control program from a layman's point of view are presented by Mr. Owens. He argues that stress should be laid on prevention rather than on control, and looks to the engineer to provide a satisfactory solution in the form of a reservoir system that will make recourse to floodways unnecessary.

Perhaps the leading industry of the Mid-South today is the production of oil and gas. And, as Mr. Barton points out, credit for its present status is due largely to the engineer, who in a few short years has transformed hit-or-miss prospecting and rule-of-thumb operating methods into a scientifically controlled and correlated enterprise.

Some of the more important of the undeveloped resources of the Mid-South, as described by Mr. Hodges, are the healing waters of its warm springs, its bauxite and other mineral fields, fertile crops, and potential hydro-electric power sites. Technical engineering, says Mr. Hodges, will continue to play an increasingly important part in the future development of the Mid-South.

The Industrial Development of the Lower Mississippi Basin

By HARVEY C. COUCH

PRESIDENT, ARKANSAS POWER AND LIGHT COMPANY, PINE BLUFF, ARK.

PROSPERITY in any area is measured by the standard of living enjoyed by the inhabitants, and although its attainment depends upon a complexity of factors, it is still the reward of energetic and efficient production, and must of necessity depend upon fundamental advantages of soil, climate, power resources, raw materials, and availability and proximity to markets. The luxuries of yesterday have largely become the necessities of today, just as the luxuries of this era will become the simple necessities of the next.

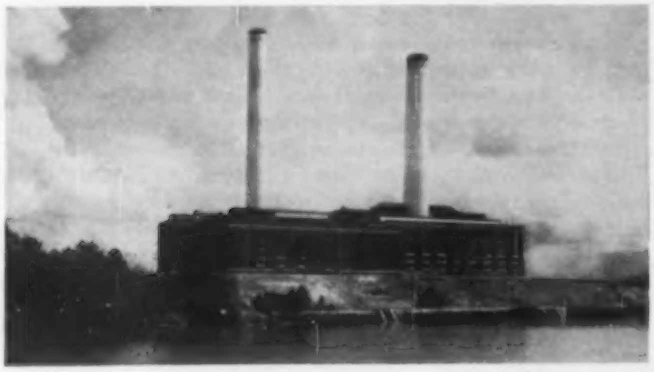
When we speak of the lower Mississippi basin we mean roughly the area beginning just south of Cape Girardeau on the Mississippi River and extending to its mouth, including parts of the states of Illinois, Missouri, Tennessee, Arkansas, Mississippi, and Louisiana, but more especially the three last named. It is my expectation that within the next two decades this area will lead the entire country in an industrial development such as we can scarcely dream of at present.

LARGE BAUXITE PLANT AS VIEWED FROM THE AIR, BAUXITE, ARK.

In making this prophecy, I have in mind the influence of environment which gives rise to the exchange of goods, the productive capacity of the lower Mississippi basin, the demand for its products elsewhere, and the revolutionary changes made possible by the recent development in the chemical and physical aspects of industry. The United States, England, Germany, and France have made more rapid progress than other nations in the utilization of science, power, transportation, machinery, and the rapid exchange of ideas. The United States, with less than 6 per cent of the world's population, now produces 40 per cent of the world's goods. No longer is there need for local self-sufficiency.

Nowadays every citizen of the United States has the equivalent of more than sixty slaves through the use of coal, petroleum, natural

gas, and falling water, and their distribution by means of electricity, and thus he has increased his productive capacity more than a hundredfold. As a result of this advantage the worker of today receives more pay for a six-hour day than his predecessor in Revolutionary times



STEAM-ELECTRIC GENERATING STATION AT STERLINGTON, LA.
On the Ouachita River; Uses Natural Gas

did for fourteen hours of toil. Under normal conditions the workers in mills and factories enjoy more luxuries in food and recreation than did the wealthiest classes before the industrial era. The cause of these changes involves many different items, such as the utilization of power; the increased mechanization it has induced; the distribution of natural resources; the application of industrial processes to farming; the effect of climatic conditions; the perfection of means of transportation; and the gradual changes in the social order which are now going on in this country.

Notwithstanding the recent depression, this is an age of optimism—in striking contrast to the pessimism of the past when it was believed that the bulk of the population was predestined to inescapable poverty. The South has already led in the recent recovery from world depression, and its future outlook is particularly favorable.

HISTORY GIVES THE BACKGROUND

To understand the present situation in the South one will do well to review briefly the industrial progress of the United States as a whole. Its industrial development really dates from the close of the second war with England, since prior to that time most of our manufactured products were brought over from the mother country. But following that war, and protected by the Embargo Act of 1807 and the Non-Intercourse Act of 1809, the available capital of this country began to be diverted from shipping to manufacturing plants to turn out the articles necessary for the comfort and prosperity of our people.

Of these manufacturing plants the cotton mills were developed first, largely in the New England states on account of the availability of water power and the abundance of labor, and the fact that these states were not nearly so well suited to agricultural pursuits as were their more southern sisters. Thus, the area of industrial development in this country became centered in the northern states and there was very little manufacturing in the South. With the dawn of steam in 1815 and the recognition by European capitalists of the independence of the Colonies, the factory system of this country was first firmly established. The cotton, wool, and iron industries had grown to healthy proportions by 1830, but not until some time thereafter did the railroads begin to open gateways to industrial development for the agricultural and raw products from the West and South to the established area of the North and East.

When transportation made possible the exchange of agricultural products for manufactured goods on a wider scale, the economic life of the country was changed. New England continued its industrial pursuits; Pennsylvania turned to coal mining; and the South to the production of cotton. Credit from abroad and gold from California provided the capital for the growth of manufactures; this was not interrupted until the Civil War, which engaged the efforts of a large part of the population.

Between 1830 and 1860 there also occurred in this country the greatest agricultural expansion the world has ever experienced. After the Civil War, the absence of internal political barriers to trade extended domestic markets over the three million square miles of the continental United States, and each section of the country began to engage in activities for which it was best suited, exchanging its surplus for needed goods from other sections. Between 1860 and 1910 the United States became one of the leading nations in manufacturing.

The end of the nineteenth century found this country fairly well divided along industrial lines. First there was the North and East, which had practically a monopoly on industrial development, with manufacturing plants located in the densely populated sections of New England, New York, and Pennsylvania. Then there was the vast western territory where manufacturing was beginning to take hold in some of the large centers, such as Cleveland, Detroit, and Chicago. And finally there was the South, which was largely agricultural and which provided the raw materials to keep the mills of New England running, to furnish the material for the furniture and automobile factories of Detroit and Grand Rapids, and bauxite to supply raw material for the aluminum plants of Niagara Falls, Massena, and East St. Louis.

In 1879, however, there came onto the stage a new invention, which was to cause a decentralization of industry and mean much to this country, but especially to the southland. I refer to the discovery of electric lighting and the use of electric power developed by

TEXTILE PLANTS HAVE MOVED TO THE SOUTH
Interior of Mill at Malvern, Ark.

Thomas A. Edison. Although the development of electric service was fairly rapid for the more congested areas from 1882 to 1900, it was not until after 1900 that the transmission of power over long distances began to play its part in the economic life of this country, and it was

not until 1910 that transmission lines of any length—by that I mean more than 15 or 20 miles—made their appearance here. The 100,000 miles of high-voltage lines in the United States at present is a measure of the tendency toward the decentralization of industry, which is rapidly changing our economic life.

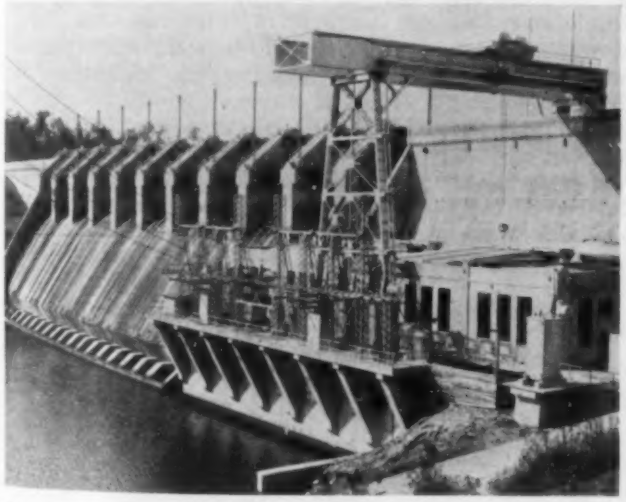
NEW CONDITIONS FAVOR THE LOWER MISSISSIPPI VALLEY

With power now almost universally available and transportation radically improved, the slum conditions associated with factories will gradually disappear and labor difficulties can be solved with improved living conditions. The lower Mississippi basin offers to industry a new set of factors which will govern the location of many manufacturing plants. With these the engineer should be familiar.

As previously defined, the states of Arkansas, Louisiana, and Mississippi largely comprise the lower Mississippi basin. In total area they represent nearly 150,000 sq miles, or one-twentieth of the United States; in them live nearly 6,000,000 people, or one-twentieth of the population of the country. So, from the standpoint of population density they represent the average for this country. The proportion of negroes is higher than in other sections but nearly all the white population is native born. For industrial development this indicates one large reservoir of cheap labor and another capable of highly skilled work.

From a marketing standpoint, it is interesting to note that within 500 miles of Hot Springs, Ark., live over 30,000,000 people, or nearly one-quarter of the entire population of the United States, and with modern transportation this means only overnight travel. Gulf ports are strategically located for trade with South America.

The climate is classified as humid subtropical, with short mild winters and long growing seasons, particularly adapted for cotton and pine. Cotton is grown only where the frostless season is more than 200 days and where the average summer temperature does not fall below 77 F. The South produces over half the world's cotton, and these three states produce a fourth of the United States' crop. Although other countries have increased their



CARPENTER HYDRO-ELECTRIC STATION, NEAR HOT SPRINGS, ARK.

production in the last twenty years, there is no other area in the world as large as the cotton belt of the South where cotton can be produced without the expenses incident to irrigation. The continued supremacy of this country, however, depends upon labor costs comparable to those of other countries, or upon the development of mechanical pickers. The development of cheap power in the South and the labor difficulties in the East have brought the textile mills nearer to the source of production, so that now more than 65 per cent of the cotton spindles of the United States are south of the Mason and Dixon

PULP AND PAPER MILL AT BASTROP, LA.
This Is a Growing Industry

line. Many of these plants are located in the lower Mississippi River basin.

STILL PROGRESSING IN COTTON UTILIZATION

Even yet cotton is transported to other sections for manufacture into goods consumed locally. In the last five years nine garment factories have moved to Mississippi and now employ over 3,000 women and girls.

Science is rapidly developing new uses for cotton and other agricultural products. Cottonseed, which was once considered a waste product, has been converted into a $200,000,000 crop; and cotton linters, another "farm waste," is now a base material in the manufacture of rayon and the coated fabrics that go into handbags, wall coverings, and automobile upholstery. Billiard and golf balls, hairbrushes, combs, electric insulators, photographic films, the unseen binder in safety glass, all contribute their tithe to the cotton farmer, and are indicative of some of the new industries that may develop further in this area.

More than 10 per cent of the cotton crop now is sold to factories for over a hundred different uses, ranging from the glycerines used in explosives to the carbon dioxide used in making "dry ice." The wallboard industry, which is revolutionizing building practices, is based upon chemical conversion of farm by-products that only a decade ago were considered worthless. The use of cotton in road-building may develop a market for over two million bales. Science may also find means for eliminating the 6 1/2 billion dollars lost annually in agricultural areas as a result of insects, weeds, and plant diseases. Eventually fuel may also be derived from annual crops.

Unsurpassed in fertility, our soils are capable of producing a wide variety of crops and of supporting a much greater population. With flood control now becoming a reality, there is likely to be a tremendous expansion in agriculture in the Valley. The farm products of Arkansas, Louisiana, and Mississippi are now valued at $422,000,000 annually, and this amount will, I prophecy, be more than matched by the industrial development of this area within the next two decades.

PINE PRODUCTION SPURS INDUSTRY

In the lower Mississipi basin, pine trees grow more rapidly than in any other section of the country, and here are found the only remaining large stands of virgin

MODERN PLANT OF PLEASING APPEARANCE, AT JACKSON, MISS., MANUFACTURES LUMBER AND OFFICE FIXTURES

hardwoods. New uses for the cut-over pine lands of the South have been found in the manufacture of paper. These lands are capable of supplying all our paper requirements, but at present their use is confined largely to the manufacture of wrapping paper, commonly known as kraft paper. In spite of the recent depression, the consumption of such paper has increased over 50 per cent in the last five years, and the importance of paper in industry is constantly growing.

In Arkansas, Louisiana, and Mississippi, there are now paper mills with a total capacity of over 2,700 tons per day, representing an investment of over $100,000,000. Another is being constructed at Crossett, Ark. Because of climatic conditions and the availability of low-priced power in this area, the production cost of kraft paper is much lower in these three states than anywhere else in the country. Further, it is my prediction that during the next twenty years we will see the paper industry of this country largely located in the southern pine belt, manufacturing not only kraft paper but newsprint as well. Instead of some 2,700 tons per day in this area, more than ten times that much will be manufactured, and this industry alone will grow in the next few years to an investment of over one billion dollars.

Much of the hardwood lumber that is now shipped to other states will be made into furniture as markets develop. This industry, which once was concentrated in the Lake states, has shifted to the Southeast and appears likely to spread westward into the Mississippi Valley.

Recent revival of the building industry is reflected in the increased activities of sawmills. At Bogalusa, La., is the largest sawmill in the United States. The lumber industry accounts for a large part of the $466,000,000 annual value of products manufactured in Arkansas, Louisiana, and Mississippi.

At Laurel, Miss., is established a new kind of lumber-producing plant which bids fair to revive the days of the vast virgin forest of the South. In this plant cut-over pine and some of the more common hardwoods are made into pulp by a special process, and the fibers are subjected to heat and pressure so that a board is manufactured of any desired size or length, which in many characteristics is superior to lumber cut from virgin timber. This industry undoubtedly will grow, and much of our future building supplies will be so produced and will be shipped, cut to measure, from this area.

OIL, TOO, IS A POTENT FACTOR

The discovery of oil and gas in recent years has materially changed the economic outlook of the lower Mississippi basin, and has brought the value of its mineral products to over $70,000,000 annually. Natural gas has been found in such quantities that it is valued at less than $3^1/_2$ cents per thousand cu ft at the well, while in Illinois it is worth 8 cents, in Ohio, 17 cents, and in Pennsylvania, 22 cents. Not only has this cheap fuel attracted many industries but it has made possible the production of power at low rates. Oil has replaced coal in many industries, but Arkansas still produces both anthracite and bituminous coal in large quantities for domestic heating in the northern states. Other valuable mineral resources include bauxite, of which over 90 per cent of the domestic supply comes from Arkansas; sulfur, from the Louisiana coast; salt, from domes in Louisiana; and bentonite, which has led to recent developments in Mississippi. Large chemical plants have recently been erected at Baton Rouge and Lake Charles in Louisiana. At Magnet Cove, Ark., only a few miles from Hot Springs, are found more different minerals than at any other spot in the world, and Arkansas boasts the only diamond mine in North America. Titanium and cinnabar ores are being developed, and there is an indication of a revival in the lead and zinc fields of Arkansas.

Oil refining has developed into an industry that employs thousands. The mid-continent field is by far the largest and most important oil-producing area in the world. From it comes the bulk of the oil in this country, which is valued at over five billion dollars annually. It has played a large part in contributing to the industrial development of the country. New wells are being brought in almost daily, which together with proven reserves, will continue to preserve the importance of this tremendous reservoir of energy.

With the increasing importance of power, the advantages of soil and of climate, the proximity of so many raw materials, and of rapidly increasing markets, the industrial development of the lower Mississippi basin stands on the threshhold of a new area of living.

The Future of the Railroads in the Southwest

By L. W. BALDWIN
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
PRESIDENT, MISSOURI PACIFIC LINES, ST. LOUIS, MO.

FORECASTING the future of the railroads in the Mississippi Valley and the great Southwest is especially difficult today. For half a century it has been fairly easy to anticipate future development for any reasonable period, with the possible exception of the present. No one, no matter how well informed or how far-seeing, could have foreseen the length and depth of this depression.

Until recently transportation meant only railroads in this country. In the last fifteen years it also has come to mean highways, pipe lines, waterways, and airways. And vastly more important than most persons realize, it also means private conveyances—principally privately owned and operated automobiles.

American railroads are popularly believed to be in the doldrums. In a measure this is a result of the difficulties

in which they have become involved—largely through no fault of their own—and partly as a result of changing conditions which they are not in a position to overcome. But railroads still are, and for many years will continue to be, the "backbone" of the transportation structure in this country. Undoubtedly the territory bounded on the east by the Mississippi River, on the west by the Rocky Mountains, on the north by the Missouri River, and on the south by the Gulf of Mexico and the Rio Grande, is destined to be the scene of great development. Believing that this is certain to occur, the study of the future of our railroads is somewhat simplified.

FINAL OUTCOME NOT IN QUESTION

No one need worry about the ultimate future of America. Our standard of living is no myth. With only 7 per cent of the world's population and 6 per cent of the world's area, America owns about half the wealth of the world; has a purchasing power greater than all Europe combined; produces almost half the foods—and consumes the major part of what is produced; mines 60 per cent of the minerals; owns and uses half of the communication facilities; produces and consumes half of the output of electricity; owns and operates 40 per cent of all the railroads; imports and consumes half of the coffee, tin, and rubber, one-fourth of the sugar, and three-fourths of the silk; consumes one-third of all the coal and two-thirds of all the oil; has constructed and uses daily more than 600,000 miles of hard-surfaced highways; and spends annually four billions of dollars for education (more than all the rest of the world). Any nation that can boast of such accomplishments does not need to defend its standard of living.

So if it is admitted that the ultimate future of America is reasonably "safe," at least for a few generations, and that the Mississippi Valley and the great Southwest are destined to be the theater of a great development within a few years; and if it is agreed that our standard of living is very real and very worth while, we can proceed to a consideration of some of the major difficulties of our railroads.

Our first major problem for both the railroads and other forms of transportation is the depression. Important as it is at the moment, and profoundly as it affects all forms of transportation, it is a transient phase, which is certain to pass. We have had 34 depressions since the United States of America became a nation. We have recovered from them all except the present and we will eventually recover from that. All had the same causes and all the same cures. This one will end as they did.

This country can solve any problem except possibly one classified as economic and political. Our economic troubles are eventually cured by natural laws and our political difficulties are usually overcome when our mistakes arouse the passions and the prejudices and the emotions of the American people.

We never have been able to balance production and consumption satisfactorily. I doubt if we shall for many generations. When surpluses begin to pile up, we do not stop producing until they are so huge that they finally fall of their own weight and crush us under a "depression." When surpluses are exhausted, we do not immediately and intelligently balance production; we delay until acute shortages and necessity force us to action. By that time, shortages have caused rising demands and prices and once more we engage in an era of overproduction.

But through it all, we have forged steadily ahead. We need remember only two generations back—when we were without electric lights, telephones, and running water, as well as automobiles, motion pictures, radios, airplanes, and other "modern advantages" too numerous to mention—in order to realize that at the depth of our present depression many of those who suffered most were "better off" than their grandparents were at the height of the biggest boom of half a century ago.

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CONSTRUCTING A RAILROAD BRIDGE ACROSS THE MERAMEC RIVER NEAR JEDBURG, MO.

Any nation such as ours, which within a short quarter of a century develops five new infant industries from swaddling clothes—the experimental state—to a point where they provide gainful employment and sustenance for approximately 30 millions of our population, cannot become static at this or any stage in its development. The five new giants I refer to are the automotive, the motion-picture, the radio, the chemical, and the airplane industries. None of these had reached what might be called a "stage of development" 25 years ago, and some of them, especially the radio, the airplane, and the chemical industries have not yet reached their limits. So, important as it is, the present depression is a passing phase when we consider the future of railroads and transportation.

FAIR REGULATION IMPERATIVE

Summarizing the next major problem—competition of various kinds—we can state that, whereas the railroads enjoyed a virtual monopoly of transportation less than half a century ago, they are today only the "backbone" of the structure; and they are confronted now with perhaps more widespread competition than is any other business in the nation. Not only are there highways, waterways, pipe lines, and airways, in addition to railroads, but the railroads themselves are pretty thoroughly regulated while the competition is, even now, almost wholly controlled.

Meantime we have a large surplus of transportation. It has been estimated that the quantity available is at

least five times what can be wholly utilized or economically justified.

"Competition is the life of trade," and I would not like to see the day when the competitive urge is removed, in transportation or any other line of endeavor. But all transportation should be uniformly and fairly regulated, and its use adequately coordinated.

It might be argued that the ideal economic program could be built on a government monopoly of transportation with all parts fitted together. Then each would keep its proper place and each would provide that quota of the transportation service which it is best fitted to give, and would offer it to the public at a fair price. However, in the history of civilization, man has not yet been able to devise a governmental or bureaucratic system of operating an industry such as transportation which is as economical or efficient as individual initiative and private ownership.

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RAILROAD YARDS AT DUPO, ILL.
About 13 Miles South of St. Louis, Mo.

RESTRICTIONS SHOULD BE EQUALIZED

Another major problem is lack of regulation as applied to other forms of transportation. It is not my purpose here to argue the merits or demerits of railroad regulation. There was real reason and need for it even if, at times, it may be said to have been carried to extremes and to have been burdensome to the railroads and to the public. Such regulation was not necessarily fatal so long as the railroads enjoyed a virtual monopoly of transportation.

It is essential that eventually, and as quickly as consistent with careful consideration, a fairly equitable and comparable regulation should be applied to all forms of transportation. Until that is done we will continue to have chaotic conditions in transportation.

If railroads are to be required to maintain fixed routes and service, then their competitors also should be required to do likewise. Similarly they should be required to maintain service; to accept any and all traffic offered, regardless of whether profitable; to maintain high wages, based on limited hours of service; to publish and adhere to standard rates and charges, and be punished for discriminations such as special rates and rebates under any guise; to be subject to regulation and accounting practices under rigid, legal rules; to obtain certificates of convenience and necessity before they can extend their routes or service; to be denied the privilege of abandoning lines and service without approval of public authorities; to secure approval by public authorities on financial matters; and to have imposed on them an equal share of the cost of government.

If and when these things are done and all forms of transportation are fairly and reasonably regulated, then each kind will eventually seek and find its proper place in the completed picture. Until that time comes, those elements of transportation which are regulated will suffer while others are able to profit at their expense.

SHOULD THE GOVERNMENT COMPETE?

A fourth major problem is that of the government engaging in the transportation business. Throughout history, especially in America, every such attempt has been unsatisfactory and has been made at great cost to the taxpayer. The government-owned and operated inland-waterways service enjoys a free right of way without any charge for ownership, maintenance, or taxes. It is not taxed like other forms of transportation, and in addition it enjoys countless benefits and privileges such as free terminals or the use of terminals at less than cost. It is not only permitted, but virtually compelled, to fix lower freight rates than the railroads charge; in addition, it has been permitted to make such rates as it saw fit, and to do this without the limitations imposed on the railroads.

These barge lines have not been required to pay interest on federal capital investment, and they have enjoyed the assistance of other governmental agencies, including free postal service. But in spite of all these advantages heaped upon them by the government, they have not been a success judged by any of the yardsticks we would use in measuring other kinds of transportation.

It has been proved with government figures that, while federal waterway transportation is sold for less than railway transportation, it actually costs more to produce, and that for every 40 cents charged the shipper, the taxpayers of the nation have been required to contribute approximately 60 cents more to carry the load.

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RAILROAD IMPROVEMENT IN HEAVY ROCK ALONG THE MISSOURI PACIFIC RAILROAD

MAXIMUM SERVICE AT LOWEST RATES

The final major problem is lack of coordination in our transportation planning. Until the railroads became a demonstrated success, the spread of population and the development of the country were limited largely to natural avenues of transportation, such as riverways, a

few public turnpikes, and some canals. With the extension of the railroads, vast areas of virgin territory were opened up to settlement and development, with the result that our frontiers were pushed back and finally disappeared, all in a period of less than half a century.

As other forms of transportation developed, they were allowed to grow without much regard for economic necessity. They did not have to gamble on the future development of the territory they served. Rather, they followed the lines of least resistance, and, especially in the case of highways and more recently in the case of airways, they have been laid out to serve those population and business centers which had previously grown up and been developed as a result of railroad transportation. This has had the dual effect of skimming off the cream of the traffic and of developing a large surplus of transportation.

If we had coordinated planning in the laying out of a transportation system, the American people would have all the transportation they could use at the lowest rates, under economical and efficient private ownership, operation, and management. America is entitled to the best that can be provided at the lowest rates that can be justified; but it is unfair to permit or encourage special privileges to one form of transportation at the expense of others for the purpose of undercutting rate levels.

Railroad transportation, which enables the production of perishables in California and their distribution and sale on the eastern seaboard; which makes possible the production of raw materials and their shipment thousands of miles for manufacture into finished articles, and permits their redistribution over thousands of miles, even back to the place of production—this is the greatest boon that has been contributed to the nation's industries. No business has done better in its magnificent record of achievement, efficiency, and economy, than the railroads of the United States.

PROSPECTS OF THE RAILROADS STILL FAVORABLE

The future of our railroads will depend upon the final solution of all these problems. As the depression passes, and as other forms of transportation are fairly and reasonably regulated, the difficulties of the railroads will diminish and they will have fairer competitive conditions to meet, which should stimulate the development of the highest standards of transportation service for the American people at the lowest rates that can be justified. Incidentally, our rates today are the lowest in the world and our service unquestionably is the best and most dependable.

Throughout the last five trying years, the record of the railroads has been eloquent. They have struggled courageously to maintain and improve their service, to maintain and increase employment, and to maintain and improve their physical properties.

Forecasting the future of the railroads of the Mississippi Valley and the great Southwest would be a comparatively simple matter if we definitely knew the answers to the problems enumerated. While possibly the future is not as bright and rosy-hued as it seemed some years ago, still the prospect is one to be contemplated cheerfully and optimistically. Traffic requirements, both freight and passenger, in this area will continue to grow, and all the needs of business will be adequately and promptly met by the railroads.

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SCENE ALONG THE RIGHT OF WAY BETWEEN JEDBURG AND EUREKA, IN MISSOURI

Presumably air transportation, both passenger and express, will grow, and also highway, waterway, and pipeline transportation. I hope and believe that all forms will be regulated on a parity, and stabilized; that wasteful and destructive competition will be controlled if not abolished; and that each form will eventually fit into its proper place in the whole transportation scheme. Then the public can obtain the kind of transportation it wants and needs at a cost commensurate with the service performed. The future of the railroads in the Mississippi Valley and the Southwest can then be contemplated with satisfaction and confidence. They should continue to furnish the backbone of our transportation system. They should be our most valuable taxpayers, our largest employers of labor, and huge customers for coal, oil, lumber, iron, and steel. And they should continue to carry the banner of progress and development.

Have Mississippi Floods Been Conquered?

By GROVER T. OWENS

PRESIDENT, LITTLE ROCK CHAMBER OF COMMERCE, LITTLE ROCK, ARK.

I DO not profess to have the qualifications of an engineer. But as a layman I have become interested in the flood problems both of my own immediate section—the valley of the Arkansas River—and of the entire Mississippi Valley. The following observations concern the economic aspects of these problems as I view them.

From the time of the Louisiana Purchase we have endeavored to control the waters of the Mississippi. A more appropriate word would be "confine." The idea has been to confine the waters within the banks of the stream and let them rush to the Gulf as quickly as possible. Where the banks are so low as to permit the water to flood adjacent territory, levees have been constructed, and this confinement in turn has made necessary the construction of still higher levees.

The present project, adopted by the Flood Control Act of 1928, provides for a comprehensive plan of protection from Cape Girardeau, Mo., to the Gulf, a distance of 600 miles, by strengthening the levees that existed in 1928 and by providing relief outlets at certain points for flood waters in excess of the capacity of the leveed channel. This project is well advanced toward completion. Levees between Cape Girardeau and the mouth of the Arkansas River have been repaired, and in some places set farther back from the banks, and new levees have been constructed. The Bonnet Carré spillway, completed several years ago, provides additional protection for New Orleans, and a floodway has been prepared to relieve the main channel of part of its flow in the vicinity of Cairo, Ill. In addition, Congress now has under consideration another floodway, known as the Boeuf, which would divert flood water from the Mississippi near Arkansas City, Ark., and carry it into the Atchafalaya and thence to the Gulf. The total estimated cost of the Boeuf floodway is $313,000,000.

Public interest does not permit of treating this subject solely as a problem of the lower Mississippi Valley, for there is a community of interest throughout the entire Mississippi drainage area. And this area is the storehouse of the nation. It produced 70 per cent of the country's agricultural products, 50 per cent of its manufactured products, and 60 per cent of its exportable surplus. It contains 98 per cent of our iron ore deposits, 82 per cent of our coal, and over 70 per cent of our petroleum stores. Let us look at the problem of Mississippi flood control, therefore, as one that is national in scope.

FLOOD PREVENTION BETTER THAN FLOOD CONTROL

I think the only safe and sound solution must be based on prevention rather than control. We must find a way to keep the water in the lower valley from reaching flood stages, rather than accept a great volume of water as inevitable and then attempt to harness it so that it will stay within artificial embankments. Prevention is a permanent method; control obviously will require continual construction in all the years to come.

Flood heights are apparently increasing from year to year. It seems to me that this must be due to the removal of the timber and the lack of reforestation to conserve the soil and delay the movement of the water or retain it in the rainfall area. I am informed that during the past twenty-five years the ground-water level has dropped over 20 ft in the territory between the Missouri River and the Canadian border. As the rainfall, measured by average years, has been more or less the same throughout this period, it seems plain to me that we have taken from the watershed the "prevention" that was formerly supplied by nature and have substituted nothing in its place.

What we should do, I submit, is to retain the rainfall as nearly as possible in the area in which it falls, make use of it in that area while it is there, and during periods of heavy rainfall permit the excess to enter the great Mississippi gradually in such quantities as to prevent floods in the lower basin. In the latter area, then, only a very nominal bank protection should be necessary.

I have read with a great deal of interest House Document No. 259, 74th Congress, 1st Session, titled "Comprehensive Report on Reservoirs in Mississippi River Basin." This report is in the nature of a recommendation from the Chief of Engineers, U. S. Army, the Board of Engineers for Rivers and Harbors, and the Mississippi River Commission to Congress, pursuant to Section 10 of the Flood Control Act of 1928. Its purpose is to show how the floods may be prevented, in part, by the establishment of a reservoir system in the drainage basins of the tributaries. It is estimated that the construction of these reservoirs will cost in the neighborhood of $1,126,000,000, of which $550,000,000 represents the cost of flowage, railroad, highway, and other damages.

This task is enormous, but the expenditure of a billion dollars to protect persons and property in the lower Mississippi Valley is to my mind fully warranted by the benefits to be derived both locally on the streams that send their waters into the Mississippi, and in the Valley itself.

There have been seven major floods in the lower Mississippi Valley in the past thirty-five years. Of these, the flood of 1927 was the maximum. Considering both the direct damage to persons and property, and the enormous loss of fertile soil through erosion, the prevention of a recurrence of the 1927 flood would in itself, it seems to me, fully warrant the expenditure. But in the lower Valley, along the Arkansas River and other streams, there are annual overflows that would also be prevented.

THE BENEFITS OF A RESERVOIR SYSTEM

"The benefits from further flood control of the Mississippi River which may be attained by reservoirs in the tributary basins," says the document, "lie in the possibility of eliminating recourse to floodways for the escape of excess flood waters or in reducing the frequency with which the floodways must be used; in affording greater safety to the main river levees by reducing the heights to which flood waters rise against them; and in reducing the area flooded by backwater through the opening left for the outflow of tributary streams."

Of course, the general plan provides for reservoirs on practically all the tributaries. But of the more than 150 reservoirs in the comprehensive plan, the 26 on the Arkansas and White rivers would be, it is said, the most effective in controlling the floods on the main stem of the Mississippi. My information is that had they been constructed and in use during the 1927 flood they would have caused a reduction in the flood crest of the Mississippi at and below Arkansas City of 5.38 ft. In addition they would minimize damages from local Arkansas and White River floods, which amount to about $6,000,000 annually. The cost of these 26 reservoirs is estimated to be $126,000,000, and seems to me to be entirely warranted.

The report of the Corps of Engineers takes into consideration the possibility of coordinating flood control and water power development. My opinion is that this coordination may be perfected in such manner as to retain as nearly as possible the maximum prevention of floods and the conservation as nearly as possible, of the actual and potential power development resources of all the streams.

Attention should also be given to the prevention of soil erosion. The White River alone, for example, carries into the Mississippi each year 3,000,000 tons of the best soil in the lower Valley. It is not difficult to visualize the enormous loss caused by similar action over the entire Valley. It seems to me also that a great deal of this sediment must be deposited in the bed of the Mississippi and under the present plan must cause additional expense for higher levees.

There are several flood-control bills before Congress at the present time. House Bill No. 8455 is a measure authorizing the construction of a great many of these reservoirs. It does not appropriate funds but is one step toward recognizing the necessity for prevention rather

than control. There are also some measures, such as Senate Bill No. 3531, which provide for floodway relief. Perhaps there is need for floodway relief at various points, in addition to the reservoirs. But if the latter will prevent the water from reaching the lower basin in such quantities as to flood its alluvial soil, then it would seem almost a sacrilege to take water from the Mississippi and permit it to flow over virgin soil, thereby removing that soil from agriculture or any other development.

There is no problem facing our nation which is of greater importance than flood prevention. I have not confined my remarks to the lower Mississippi, for I feel we should remove the cause, which lies outside that region, rather than control the disease, and at the same time make every possible economic use of the waters that cause our troubles.

Oil and Gas Resources of the Mid-South

By T. H. Barton

President, Lion Oil Refining Company, El Dorado, Ark.

ONLY a little more than 75 years ago the first wildcat oil well was completed at Titusville, Pa., by Col. E. L. Drake. After months of effort, this optimist had at last been rewarded by a well from which crude oil could be obtained.

At that time even the coal-oil lamp was a "modern discovery" that was still to be perfected—one of the main objects of Colonel Drake's effort had been to secure mineral oil for medicinal use. Yet within a little more than three-score years the security of nations, the movement of the wheels of industry, and even social pleasures have become so dependent upon crude oil and its products that it is difficult to conceive of existence without it.

A Modern Oil Refinery at El Dorado, Ark.
This Plant Has a Capacity of 13,000 Bbl per Day

It is fortunate for us of the Mid-South that the greatest of all the world's known oil and gas resources occurs here. Today 65 per cent of the nation's supply of crude oil comes from Oklahoma, Texas, Arkansas, and Louisiana, and if the existing wells of these four states were operated at capacity they could supply the nation its entire daily requirements of 2,800,000 bbl of crude oil. The known reserves of oil in the ground total billions of barrels. Our gas deposits, available through networks of pipe lines extending to Monterey, Mexico, on the southwest, Atlanta, Ga., on the east, and St. Louis, Mo., on the north, serve all the large cities and most of the small communities in the South. Yet many of these gas deposits are today being drawn upon but lightly, or are even idle, because of the present abundance of the supply.

Outstanding, of course, among the oil fields of the Mid-South is the great east Texas area, chiefly in Rusk and Gregg counties. Here 130,000 acres of oil-bearing land is estimated to contain $2^1/_2$ billion barrels of recoverable crude oil. The oil is of high gravity and cheaply obtained, and available by pipe line to the large refining centers in Arkansas, Louisiana, and south Texas. The new Rodessa field, in northwest Louisiana and adjacent Texas and Arkansas, is in its infancy now, but is already capable of at least a 200,000-bbl per day production. This pool probably extends for thirty miles and in time will become one of the outstanding oil fields of the country. Rodessa oil, however, lacks the quality of east Texas crude, and the Rodessa wells are drilled at a cost of $65,000 as against $15,000 for an east Texas well. Produced under present proration restrictions, such first-magnitude pools as those of Oklahoma City and Fitts in Oklahoma; Conroe, Van, Yates, and Hastings in Texas; and Iowa in southern Louisiana, will form for years to come the bulwark for a reliable supply of crude oil. These "limelight" pools, however, are supported by hundreds of older pools and smaller newer pools of less spectacular nature.

Oil Supply Not Inexhaustible

I do not wish to convey the idea that there is a permanent and inexhaustible supply of oil for the entire nation in the South. The best students of this subject are already warning us that we must continue to find new fields, that within the next 10 years our present known reserves will be taxed to supply the nation's ever-increasing demand, and that within 25 years, unless many new and important discoveries are made, we may find ourselves in peril from an entirely inadequate supply of oil.

I suggest that if such a time should come, the territory in which the greatest fields occur should be first served and this should act as an industrial stimulus to the Mid-South. With nearly all industry so dependent upon a reliable supply of cheap fuel and cheap transportation, our territory is clearly a favored one.

At present the large gas fields of the South lie chiefly in Texas and Louisiana. The older fields—such as Monroe, Richland, and Bethany, in northeast Louisiana—are well on the road to depletion, but such new pools as Simmsboro, Driscoll, Sligo, Rodessa, and Sugar Creek in north Louisiana offer substantial replacement, and in east Texas, Cayuga, Long Lake, and Buffalo will furnish billions of cubic feet of gas. In south Louisiana and south Texas, gas fields almost too numerous to mention are at present drawn upon but lightly. In Arkansas the great Arkansas Valley hill country has been barely scratched for gas, and at Jackson, Miss., an important field supplies the east end of the great gas system covering the South. With proper conservation, a depletion of our gas reserves is little to be feared for many years, and it is confidently expected that many more new fields of both oil and gas will be discovered in the region.

The oil industry is not only important as a stimulus to and stabilizer of other industries; it is in itself perhaps the leading industry of the Mid-South. Today in the states of Oklahoma, Texas, Arkansas, and Louisiana, in excess of 1,800,000 bbl of crude oil are taken from the ground and pumped to refineries each day. Billions of dollars have been invested in the business. Tens of thousands of men are employed and huge refineries operate in each of the four states, especially along the Gulf coast. In the east Texas oil field alone, over 20,500 wells have been drilled at an average cost of not less than $15,000 completed. Here is an expenditure of $307,500,000, and additional expenditures for pipe lines, tanks, and equipment in this field will easily bring the sum in excess of $400,000,000.

ENOUGH FUEL FOR A 6,000,000-MILE TRIP
This Spheroidal Tank, with a Capacity of 420,000 Gal, Is Specially Designed for the Storage of High-Vapor-Pressure Gasoline

Few people not actually engaged in the oil business realize what large numbers of people are employed in the fields and offices. In the El Dorado district of southern Arkansas not less than 4,500 people are employed by the producing, pipe-line, and refining divisions of the industry. One of the largest companies operating almost exclusively in the states of Texas and Louisiana employs more than 12,000 people. These figures of course do not include the marketing end—people are engaged in the sale of oil products in every hamlet and even along country roads. In Arkansas alone, there are approximately 7,500 retail sales stations for gasoline.

PROSPECTING FOR OIL ON A SCIENTIFIC BASIS

I doubt that any other industry is more completely in the hands of the engineer or more dependent upon him than the oil industry. To start with, in the search for oil, the geological engineer and geophysical engineer have complete charge of the exploration. Up until about ten years ago, the search for oil was almost entirely in the hands of the geological engineer, but then came rumblings that such instruments as the seismograph, torsion balance, and magnetometer were being used in a helpful way in locating structural conditions favorable to the accumulation of oil and gas.

In its early form, the seismograph recorded only the presence of hard rock thrust up into softer formations, and to get the required wave vibrations, large amounts of high explosives had to be discharged on the surface. But now, the seismograph engineer—or seismograph geophysicist as he is technically called—is able to map the contour of beds of hard rock lying at a distance of thousands of feet below the surface, and he needs only two or three pounds of powder to do the work. In this manner many of the large oil fields that are now producing have been located.

The torsion balance, an instrument recording the gravitational pull of the earth, indicates the presence of rocks of greater density and their proximity to the surface. In this manner the elevation of a hard, dense bed of limestone, for instance, can be determined at various points and the existing structural conditions favorable or unfavorable to oil accumulation can be located. As an oil finder, however, the torsion balance has in general proved inferior to the seismograph and has to a very large extent given way to it.

The magnetometer, which records the magnetic pull of the rocks beneath, has been useful in locating igneous intrusions and, in some instances, structural conditions where rocks containing important quantities of magnetic minerals exist. The uses of this instrument, however, appear to be restricted, and it also is of secondary importance compared to the seismograph.

Today in southern Arkansas and northern Louisiana alone, 35 seismograph crews are operating, most of them integral parts of the organizations of the large companies or employed under contract by them. The effect of this work has been to hasten the discovery of oil pools to such an extent that within a few years the oil reserves of the country will be very largely known and controlled. The recent discovery of a new field just north of the original Smackover producing area is entirely due to seismograph work, and the two new gas fields in north Louisiana, at Simmsboro and Driscoll, owe their discovery entirely to the seismograph. Today a company requiring great oil reserves to maintain its very existence is entirely dependent upon the geophysical engineer, and without him would soon lose out in the race of competition.

OTHER ENGINEERING CONTRIBUTIONS TO THE OIL INDUSTRY

In pipe-line construction, the civil engineer is master of ceremonies for the most part, although the mechanical engineer enters in the building of pumping stations, and a new variety of engineering has been introduced in the matter of aerial surveys. Most large companies make a complete aerial survey of the entire pipe-line right of way to get a good picture of the topography of the country traversed. Similar surveys are also used extensively now by the geological engineer in exploration work, and there are consulting firms whose entire business is that of making aerial surveys for pipe-line rights of way and for geological exploration.

The refining division, of course, has always been under the jurisdiction of the refining engineer—a highly specialized technician. With the introduction of modern cracking plants, this end of the business has become extremely complex, and without the highest type of engineering cannot be made profitable.

The phase of the industry which has most recently fallen into the hands of the engineer is production. For a great many years, the drilling of oil wells and the pumping of oil from them after they stopped flowing was in the hands of the ordinary field workman, and for some reason was not recognized as coming under the jurisdiction of the trained engineer. I have seen men of no special competence entrusted with the drilling and operation of wells on which $50,000 to $100,000 was expended. Now, however, all large companies and most of the smaller ones have their own engineering staffs for supervising drilling and producing operations. Many of the colleges have well-established courses in produc-

tion engineering, but because of the rather recent recognition of the need for such technicians, production engineers are still scarce.

Applied engineering has so improved the producing and drilling equipment in the last ten years that an old-timer in the oil business could scarcely recognize the operations today. For instance, it is now possible to make a complete survey of the hole while it is being drilled, from which a picture can be constructed showing exactly all deviations from the vertical and their direction. It is now possible to drill with such accuracy that a projected well, say, 6,000 ft deep and with its bottom 1,000 ft to one side of the starting point, can be put down with full assurance that the bottom will be exactly at the specified point. Near Santa Barbara, Calif., where wells are put down in the ocean floor, four wells are drilled from the same derrick platform, each one deviating in its course, so that the bottoms of the holes are as far apart as though they had been drilled from four normally spaced locations.

STEEL DERRICKS HAVE REPLACED THE TIMBER STRUCTURES OF EARLIER DAYS
An Oil Well near El Dorado, Ark.

In connection with accurate drilling I wish to mention an amazing feat of engineering that was accomplished in the Conroe field. One oil company had a well which had blown out and made a large crater on the surface. The drilling rig and derrick had both gone into the crater, which was on fire, and a tremendous amount of gas and oil was being wasted. One large company started an oil well over 600 ft south of the well that was on fire, and drilled into the producing horizon of the cratered well at a depth of over 5,000 ft. In an hour's time, the fire was killed by pumping water through the new well and into the producing zone.

Recently a remarkable electrical device has been invented that records with almost uncanny accuracy the porosity and resistivity of formations penetrated by the drill. In a well being drilled by the rotary method it is now possible, before setting the casing, and while the hole is still filled with drilling mud, to test the formations penetrated and determine the presence of oil- or gas-bearing formations and their porosity. It is a quick, practical method, and is extensively used. Even the modern "wildcatter" who has had the misfortune to get a dry hole, would not abandon it without a test with this device to see whether or not he had failed to take advantage of a producing sand.

OIL AN IMPORTANT FACTOR IN INDUSTRIAL DEVELOPMENT OF SOUTH

I have digressed somewhat to emphasize the great opportunity for engineers in the oil business. The oil resources of the Mid-South and their effect upon future development can be briefly summed up by stating that this is the favored land of oil and gas production and that the industry itself is the leader in the development of a very large part of this section of the country. Such cities as Tulsa, Oklahoma City, Dallas, Fort Worth, Houston, Shreveport, and El Dorado owe a very large part of their remarkable growth to oil. Also, innumerable towns of two or three thousand people have grown into stable, prosperous cities of fifteen or twenty thousand, solely because oil has been developed in the vicinity. Barge lines carrying nothing but oil operate on the Mississippi River, and one has only to observe the long trains of tank cars on any railroad in the Mid-South to realize the value of oil to the railroads. Baton Rouge, La., is one of the important ports in the United States solely because it is the point of departure of so many tankers carrying crude oil and refined products to different parts of the world. The future appears to hold the prospect of an even greater oil industry for the Mid-South.

Undeveloped Resources of the Mid-South

By EARLE W. HODGES

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FOR purposes of brief discussion, the Mid-South might be said to comprise the states of Kentucky, Tennessee, Alabama, Mississippi, Arkansas, Louisiana, Oklahoma, and Texas. While from the viewpoint of the average Easterner, Oklahoma and Texas might be considered southwestern states, they are really southern in climate and soil products. On the other hand, there might be added the states of North Carolina, South Carolina, and Georgia, but to the Far-Westerner these states are really eastern, or southeast Atlantic seaboard states. The outstanding accomplishments of the Mid-South reflect genuine credit upon those who have given technical knowledge, time, and money to bring its resources to the attention of the world.

The Mid-South was settled by people of all nationalities, combining to form a fine citizenry after a few decades of neighborliness and cooperation. The Carolinas and Virginia furnished much of the earlier population, but even the New England states and many foreign countries contributed large numbers, and the northern as well as other eastern states contributed many energetic pioneers and much needed capital to the Mid-South.

EARLY PROGRESS OF THE MID-SOUTH

Even before the Civil War, the central states of the South were manufacturing or producing many of their own requirements such as cotton goods, tobacco, iron and steel, manganese, salt, sugar, syrups, grain

products in merchandising form, and some semi-precious and precious metals, such as zinc, lead, silver, and gold. Lumbering and the manufacture of wood products were industries of national importance, and river transportation was at its height. Education and religious training were not neglected, and the press, then as today, was the advance guard of progress. Railroads, always national developers and builders, were just beginning their work of tying the states closer together, bringing products to the consumer, and providing markets for the manufacturer.

From 1860 to 1870 was a period of civil strife and civic waste from which the Mid-South did not quickly recover. In the seventies, however, lands were thrown open to settlement; there was a real re-awakening of interest in the South; and railroads and capital generally began an intensive campaign of nation-wide scope to develop both the West and the South. That work has been carried on constantly by states, by groups of citizens, and by individuals for three-quarters of a century, and today the Mid-South has become an extremely important section of the United States. Notwithstanding periodic devastating floods, droughts, and economic distress, the central section of the South has made constructive progress in the constant use of its own resources.

VIEW OF SMACKOVER, ARK., DURING THE OIL BOOM
Oil Was Discovered in This Vicinity in May 1922

SOME LITTLE KNOWN SOURCES OF WEALTH

Among the formerly undeveloped resources of the Mid-South may be mentioned Hot Springs National Park. The healing waters and attractive features of this park are becoming better known and more highly appreciated by the people of the whole world. The original Americans appreciated and made crude use of its hot waters in restoring health and prolonging life, and the first explorers from the Old World enjoyed the steaming streams from the hot springs and recorded the event in the story of DeSoto's journeys. More people now visit Hot Springs each year than any other national park, and the number will undoubtedly increase rapidly as the years go by.

Not so far away is located a spot of unusual interest to the mineralogist and engineer—Magnet Cove. This small area, where dozens of important minerals are found, where magnetic compasses "go crazy" and where Nature seems to have created a puzzle for men's minds, is much better known to foreign scientists and laboratory experts than to those of our own country. John R. Fordyce, M. Am. Soc. C.E., can excite amazement and interest for a whole day at Magnet Cove as he talks and guides, just as he can do in telling the story of aluminum, at Bauxite, where is located one of the world's most valuable bauxite fields.

Down in the hills, near the pretty town of Murfreesboro in Pike County, can be found the largest diamond fields in the United States—genuine diamonds, most of them pure white and flawless, and equal in quality to the diamonds of South Africa. State Geologist George Branner knows that romantic—but true—story well, from his own knowledge and from his distinguished father, John C. Branner. As a matter of interest, John C. Branner was the discoverer of the large Union County oil fields in Arkansas; he made a map and almost precisely located the oil fields at El Dorado and Smackover nearly forty years before the first well was brought in there. Arkansas is also rich in fruits, rice, timber, and minerals.

MINERALS AND OTHER NATURAL RESOURCES PLENTIFUL

In Oklahoma the earth has held treasures for ages. Nature was extremely generous in storing oil and natural gas for future use, and the state has great deposits of sands and clays that are just beginning to be developed on a large scale. Texas really has everything, as its most enthusiastic citizens claim. It is a state with all climates—seashore and mountain, plain and valley. Its huge deposits of sulfur and salt have been profitable, but probably the largest beds are yet to be developed; many are still not definitely located. The oil fields of east Texas are the world's greatest, with more than 20,000 producing wells.

Louisiana offers—even to this day—virgin timber which the axe has not touched, the finest sugar-cane soil in America, rare hardwoods, oil and gas fields barely tapped, carbon-black manufacture, waterways of importance in common with the majority of the Mid-South states, and cities and other places of unusual historic interest. Kentucky and Tennessee are prospering in the general use of natural resources, from great hydroelectric projects to rayon manufacture, from stone quarries to increased tobacco and cotton production and manufacture, and from phosphate beds to coal and bauxite.

Mississippi is also rich in developed and undeveloped resources, with a fertile soil perhaps unequaled anywhere. Transportation on the Mississippi River and in the Gulf of Mexico is properly being capitalized more each year. Alabama particularly can point to the development, past and present, of the iron and steel industry, and to the production of cotton and the manufacture of cotton products.

No attempt is here made to name the wonderfully progressive cities and towns in the Mid-South, nor to designate particular places of beauty or of commercial or social importance; it is merely hoped that this may serve as a brief reminder that Nature has been good to the Mid-South; that man has done much, and that even now only a fair start has been made on the real development that is to come. Transportation to the four corners of the earth by air, river, sea, and land is at its door, and man will make even greater use of all these facilities in the future.

Technical engineering in all its useful branches or divisions has had much to do with the past progress of the Mid-South and will continue to play an increasingly important part in its future development. Research and science will continue to work hand in hand.

Through its colleges, schools, and newspapers, the Mid-South has been a great developer of character and better citizenship in the past; it will do more in the future. Character is its greatest asset.

Problems at Conchas Dam

Advance Studies on Materials, Design, Water Supply, and Operation

By Gerard H. Matthes

Member American Society of Civil Engineers

Principal Engineer, Office of the President, Mississippi River Commission, Vicksburg, Miss.

Conchas Dam, a straight gravity structure containing 700,000 cu yd of masonry, is located on the South Canadian River just inside the border of New Mexico, adjacent to the Panhandle of Texas. It is intended primarily for flood control but will have a generous capacity available for farm irrigation, and incidentally for municipal uses. In the extensive advance studies here described, particular pains were taken with the foundation, using borings up to 30 in. in diameter, and employing photographic methods for investigation as well as for recording purposes. A red clay shale which when dry disintegrates to fragments and finally to dust, presents a peculiar problem since its moist character must be sedulously maintained. Operation also presents its difficulties, as the rainy or impounding season corresponds with the irrigation season. An adequate supply of water must be kept available for agricultural uses at the same time that an ample reserve capacity is being maintained for flood control; and the operator must balance these conflicting demands. The paper of which this is an abstract was originally delivered before the Construction Division on April 23, 1936, at the Spring Meeting of the Society in Hot Springs.

Originally planned to be an earth embankment 230 ft in height, Conchas Dam has been twice redesigned, once in the shape of a rock-fill structure and more lately in the form of a concrete dam of the straight gravity type. Consideration was given also to stone masonry and to round-head buttress construction, either of which would have been well adapted to the conditions at the site. Restrictions imposed through the use of ERA funds as to man-year costs and the desire to spend money for labor rather than for materials such as cement, from the first dictated in favor of earth, rock-fill, and stone masonry types. The prospective removal of ERA restrictions on July 1, 1936, and the availability of regularly appropriated funds after that date, was primarily responsible for the consideration of standard concrete types of construction.

This abandonment of the earth-fill design, however, was brought about largely through the discovery of artesian water under considerable head in the foundation rock at the bottom of the canyon. Inability to control or by-pass great floods during construction also militated against the rock-fill type. For a while, the concrete gravity type of dam was deemed impracticable because the sand and gravel supply for concrete aggregates appeared to be deficient as regards both quantity and quality. Investigation later proved the sand and gravel deposits in the nearby river terraces to be satisfactory on both scores, and this led eventually to the adoption of a straight gravity dam (Fig. 1) with a total length of 1,160 ft, provided with an overfall crest having a clear length of 300 ft. In addition, wing dams aggregating 25,000 ft in length will be built across the valley, in places to a height of 80 ft. These wing dams for the most part will be dry-rolled earth fills with rip-rap facing. About 3,000 ft of wing dam will serve as a low concrete emergency spillway.

In cross-section, the concrete dam presents no novel features, following as it does rather conventional design, being slightly strengthened to provide stability against earthquake shocks. The downstream toe of the overfall section and the stilling basin immediately below it have been made the subject of model tests at the U. S. Waterways Experiment Station in Vicksburg, and it is hoped that these studies may bring about some advance in a field in which much remains to be accomplished in this country.

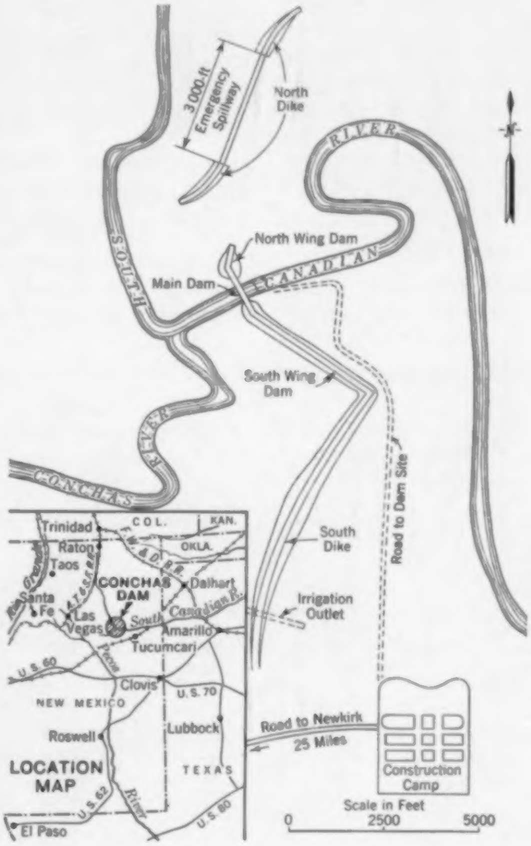


Fig. 1. General Layout and Location Map of Conchas Dam

Some General Considerations

Conchas Dam belongs in that rare class, namely, straight gravity-type dams, 200 or more ft in height, of which there are but eight in existence in the United States and the Canal Zone. Table I presents a list of straight gravity dams of the 200-ft class, completed and projected. Tygart Dam, now under construction on the headwaters of the Monongahela River, will be the ninth of the series, and Conchas Dam is likely to be the tenth. Interesting is the fact, brought out by the tabulation, that for nearly twenty years no dams of this kind were built. The practice during this period (1916–1934) was to arch all high concrete dams to secure additional stability.

Conchas Dam site (Fig. 1) is on the upper reaches of the South Canadian River, in San Miguel County, eastern New

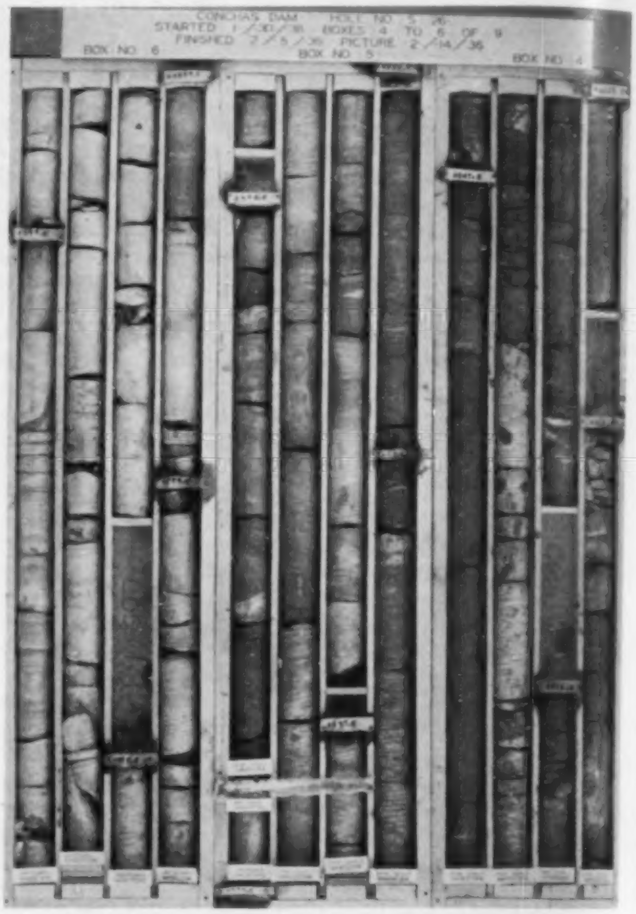
ARTESIAN SANDSTONE CORE SECTION, 30 IN. IN DIAMETER
Shattering Is Due to Blast Required to Break It Out

Mexico, in a narrow canyon immediately below the mouth of Conchas River, from which the site derives its name. The South Canadian, a major tributary of the Arkansas River, is noted for the flashy character of its discharge. At the dam site the flow varies from zero, as has been witnessed throughout the month of April 1936, to an estimated probable maximum of over 500,000 cu ft per sec from a watershed of 7,350 sq miles. The greatest flood of which there is reliable record is that of September 1904, when a peak discharge of about 200,000 cu ft per sec passed the dam site. From high-water marks it appears that during this flood the river at the site was 70 ft deep, measured to bedrock. This assumes that all sand normally forming the river bed was set in motion as sediment in suspension. At low stages the depth of sand overlying the bedrock is 23 ft.

HAS UNIQUE GEOLOGICAL FEATURES

The region is one of sedimentary formations, principally sandstones and shales, interspersed with an occasional layer of limy conglomerate or limestone. The strata lie nearly horizontal at the dam site, but assume a gentle dip toward the southeast downstream from the site. The locality is free from faults, solution channels, or cavernous rocks. River terraces are composed of gravel deposits containing appreciable quantities of sharp sand. The outstanding characteristic of the rock structure is the lack of continuity of the individual strata. For instance, a massive hard sandstone stratum, 15 to 25 ft thick, may extend for 1,000 ft or less over a lenticular area and merge suddenly into multiple layers of thin-bedded sandstone or into shales. Some of the more important shale beds are found to pinch out completely or to lose their identity.

These inconsistencies, noted at the inception of operations, led to an extensive program of exploratory



PRESERVING DRILL CORE RECORDS PHOTOGRAPHICALLY
Three Boxes Show Sequence; Uppermost Strata in Box at Right

core borings (Fig. 2), which have yielded information of the greatest service to the designers. They revealed, among other things, what could not be discerned from surface indications from within the canyon, namely, the

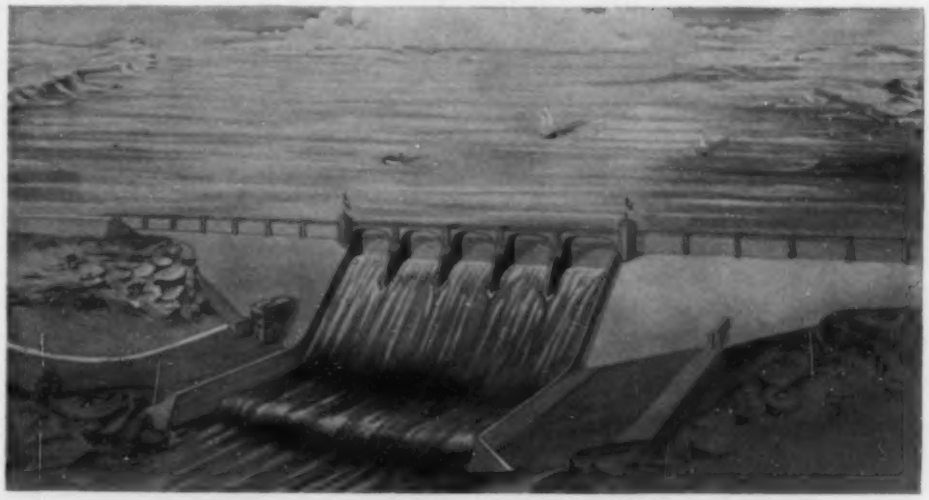
TABLE I. STRAIGHT GRAVITY-TYPE DAMS IN THE UNITED STATES 200 FT OR MORE IN HEIGHT

LEGEND
FC = Flood Control N = Navigation U.C. = Under Construction
Irr = Irrigation P = Power WS = Domestic Water Supply

Name	State	River	Year Completed	Purpose	Max Ht Above Bedrock In Ft	Height Above River Level In Ft	Crest Length In Ft	Volume In Cu Yd
Grand Coulee:								
Ultimate	Washington	Columbia	U.C.	FC, Irr, P	550	475	4,200	10,500,000
As now authorized .	Washington	Columbia	U.C.	FC, Irr, P	177	150	3,600	3,500,000
Kennett	California	Sacramento	U.C.	Irr, P	420[a]	(?)	2,430	3,420,000
Morris	California	San Gabriel	1934	WS	328	245	780	480,860
Kensico	New York	Bronx	1916	WS	307	170	1,843	913,000[c]
Elephant Butte . . .	New Mexico	Rio Grande	1916	Irr	306	203	1,155	618,536
Norris	Tennessee	Clinch	1936	FC, P, N	266	243	1,872	1,195,000
Seminoe	Wyoming	Platte	U.C.	FC, Irr, P	260	(?)	600	163,000
Friant	California	San Joaquin	U.C.	Irr, P	252	(?)	3,800	1,328,000
Olive Bridge	New York	Esopus Cr.	1912	WS	252	212	1,100	459,000[c]
New Croton	New York	Croton	1906	WS	238	166	710	855,000[b]
Tygart	West Virginia	Tygart	U.C.	FC, N	235	(?)	1,850	1,100,000
Wachusett	Massachusetts	Nashua	1906[d]	WS	228	207	971	266,663[b]
Conchas	New Mexico	So. Canadian	U.C.	FC, WS, Irr	228	190	1,160	700,000
Madden	Canal Zone	Chagres	1935	N, P, FC	223	179	974	523,768

[a] Height of 520 ft under consideration
[b] Rubble masonry
[c] Cyclopean concrete faced with stone or concrete blocks
[d] First American dam designed with upward pressure

existence of a 65-ft stratum of red clay shale which will form an important part of each canyon wall, and into which the concrete structure will have to be keyed. On investigation, this shale proved to be of good quality—compact, relatively heavy, and highly impervious in the undisturbed state. It possesses, however, one serious limitation, that of slaking in contact with dry air, a process which progresses with rapidity and which reduces the shale to a crumbling mass and ultimately to dust. Immersed in water, however, it tends to retain its firm qualities; in fact, any coating which prevents its 7 per cent moisture content from evaporating appears to preserve its integrity. The program of abutment excavation and placing of concrete therefore calls for unusual care in the treatment of this shale, in order that it may in no wise become impaired through exposure.



Perspective Rendering of Conchas Dam as It Is Proposed to Build It

Underlying the red shale (Fig. 2) is a pink sandstone varying in thickness from 30 to 40 ft. Only a thin layer, almost worn away by river scour, comprises the rock bottom of the canyon, and forms the immediate foundation for the dam. It, in turn, is underlain by a massive white sandstone which, to the designers, is the foundation rock proper, while the superimposed pink sandstone assumes much the rôle of a veneer, parts of which, upon stripping, may prove to be so shaly as to require removal. The massive white sandstone has a thickness of more than 200 ft; in some of the drill holes it was found to be divided by a 15 to 40-ft stratum of red shale similar in composition to that previously described.

BORINGS DISCLOSED UNUSUAL CONDITIONS

At the inception of core-boring operations, artesian water was encountered in the white sandstone. In the first hole to be drilled in the canyon it rose 130 ft to the surface, confined by the impervious red shale walls of the hole. The water proved to be highly mineralized and carbonated, and had a strong chalybeate flavor. This hole was some 2,500 ft downstream from the axis of the proposed dam. Some of the drill holes at and near the axis (Fig. 2) developed into small gushers, and showed an artesian pressure equivalent to a 70-ft static head at the surface of the foundation rock. As more holes were drilled, the pressure was appreciably reduced.

In order to permit more detailed examination of the foundation rock, use was made of periscope observations in special holes 8 in. in diameter; also, direct observations were made in holes 30 in. in diameter. Only a few of the latter size were drilled.

Much thought has been given to preserving drill-core records for future reference. Photography has been of considerable assistance. Soon after the cores are brought to the field office, and before they are handled for examination and identification, the core boxes and their contents are photographed. One of the photographs shows three such boxes, placed in sequence, containing foundation rock cores—pink shaly sandstone and white artesian sandstone, the contact line between the two being shown by a strip of cloth tacked to the center box. The metal tags indicate the tops and bottoms of successive core "pulls." Stamped on each tag is the elevation above mean sea level.

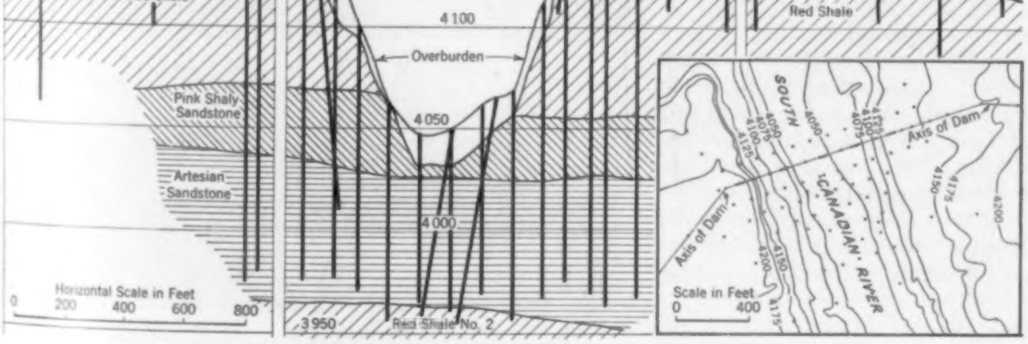


Fig. 2. Geological Profile on Axis of Conchas Dam, Showing Borings

Photography, in an experimental way, has been applied to the interior of the larger drill holes with the aid of 16-mm motion picture film. The object here is to

LOOKING NORTH ACROSS THE CANYON ALONG THE AXIS OF THE DAM

preserve a visual record of the rock and the nature and position of all seams and partings. It is believed that this will be of assistance in correlating such features with the results of the pressure tests, which have been carried on extensively. Taken in connection with each other, these should furnish a clear understanding of subsurface conditions and should make possible the intelligent planning of pressure-grouting operations.

IRRIGATION AND WATER SUPPLY, AS WELL AS FLOOD PROTECTION

Flood control is the immediate purpose of the Conchas Dam, but the design permits of the ultimate use of the reservoir for supplying water to irrigate 60,000 or more acres of farming lands in the vicinity of Tucumcari, N.Mex., and to supplement the municipal supplies of Amarillo, Tex., and Tucumcari, N.Mex. The project as a whole ranks among the worth-while undertakings of the federal government. Flood damage along the South Canadian River below the dam site has averaged $175,000 annually in the past, mostly in Oklahoma and Texas. Reduction of Mississippi River flood stages is not contemplated however, as the 1,000-mile distance by river to the Mississippi places the latter well beyond the zone of effectiveness of flood storage at the Conchas site.

Flood control by means of headwater storage, as here planned, should be effective for lands in the watershed of the South Canadian River. It differs markedly from the usual oblong shape of drainage basins, averaging less than 40 miles in width over a length of 500 miles below the dam site. Upstream from the dam is a fan-shaped headwater area located on the east slopes of the high Sangre de Cristo mountain range which forms the divide between the Rio Grande and the Arkansas River. Intense floods originate in this headwater area and produce flood crests which receive no appreciable increments from the short tributaries farther downstream. Conchas Reservoir, which will be at an altitude of 4,200 ft above sea level, will control the storm runoff from this entire headwater area, except for the watershed of 2,000 sq miles drained by Ute Creek.

The reservoir is planned to have an effective storage capacity of 500,000 acre-ft, of which the lower 300,000 acre-ft will be reserved for the storage of irrigation water, while the upper 200,000 acre-ft will be dedicated to flood control. The concrete overfall section of the dam, designed with its crest at the top of the irrigation pool, 160 ft above the present river level, will have a discharge capacity of 75,000 cu ft per sec with a depth of water of 17 ft on the crest. This depth corresponds to the 200,000 acre-ft flood-storage capacity, and brings the water level flush with the crest of the emergency spillway, to be built some distance away from the dam and designed to discharge unlimited flows into the canyon below the dam. A 5-ft depth of spill on the emergency crest would add a surcharge of 250,000 acre-ft to the flood-storage capacity, and leave a depth of 5 ft of freeboard below the top of the dam.

Certain construction problems presented by the 4-mile wing embankments and the 3,000-ft emergency spillway are not as yet completely solved. For the construction of dry rolled fill, the locality affords a variety of soils, the characteristics of which are being studied at the Soils Testing Laboratory of the U. S. Waterways Experiment Station at Vicksburg, Miss., and also at the dam site in a practical way to determine their relative merits. All the soils in the vicinity of the site are mixtures of the residuals left from the erosion and decomposition of sandstones and shale strata in the local mesas.

As the texture of these shales varies widely—from thinly laminated sandstones to compact clay shales—and as individual beds are only from 5 to 15 ft thick, the residual soils show much variation, and occur mostly in deposits of limited extent, often averaging only 5 ft in depth over areas rarely exceeding 1,000 ft in diameter. Those soils, which are available in large quantities, are in the nature of sandy adobe, in places so rich in clay as to be suitable for the manufacture of sun-dried adobe bricks. The engineers have not been slow to take advantage of this and have in operation a plant which produces adobe bricks for use in erecting buildings for housing the construction forces.

Laboratory tests indicate a high degree of compaction for most of the soils from which "undisturbed" samples

DUPLEX APARTMENT FOR GOVERNMENT EMPLOYEES
Constructed Partly of Adobe Brick and Partly of Stone in Cement

have been analyzed, a compaction so great as to make excavation by hand methods extremely laborious. Instances have occurred, in test-pit digging, in which it took a day's work for two laborers working with pick and shovel to remove one cubic yard of material. Earth augers are slow to penetrate, and in some soils have proved wholly ineffective. The vertical walls of many of the test pits have stood for months without showing appreciable weathering. In consequence, borrow-pit location, excavating, prewetting, reduction of hard lumps before placing in the earth fills, and compaction by sheepsfoot rollers present interesting problems. The largest of the embankments will contain about 750,000 cu yd and will be 80 ft high for over half a mile. Suitable materials appear to be available within easy hauling distance. These are being experimented with at the site of the proposed embankment by incorporating them in small test dams, and in addition are being tested at the soils laboratory.

SITE OF DAM, LOOKING WEST (UPSTREAM)
Conchas River Comes in from Left Background, South Canadian from Right

PLANNING FOR BEST OPERATION

Not the least of the problems confronting the engineers is the scarcity of water for domestic as well as for construction uses. This situation is not unusual in eastern New Mexico, where there is little or no precipitation during the winter months, and many sources of water supply fail completely. The artesian water encountered in the foundation rock has not so far been found suitable for domestic use, and is not sufficient in quantity either for concrete mixing or for sprinkling rolled fills.

TEST DAM UNDER CONSTRUCTION BY ROLLED-FILL METHOD
Three Different Materials Were Utilized

Operating problems furnish food for thought. Floods descend with great rapidity. With the best of flood-warning service it is probable that not over 10 to 12 hours' notice can be relied upon, and flood magnitudes have to be forecast largely on the basis of rainfall reports. Indications are that the reservoir will rarely be full, and that it will be able to absorb most if not all of the ordinary storm runoff. However, as in the case of any reservoir that has a limited flood storage capacity and must also be used for other purposes, there is the possibility that storms in quick succession may exhaust the flood-absorbing capacity of the reservoir so that large volumes may have to be wasted over the spillways. Accordingly, discharge facilities have been designed for handling very large flows in emergencies.

For irrigation, the operating problem is complicated by the fact that the rainy and the irrigation seasons coincide. This is in marked contrast with the usual conditions obtaining farther west, where most of the rain falls during the winter and early spring months, and the reservoirs receive their season's supply before the demand for water begins. This makes it possible to plan the distribution of the water with some degree of certainty.

At Conchas Reservoir, neither supply nor demand can ever be forecast for even short periods. Whenever it rains, the farmers will need no irrigation water and the reservoir level will rise rapidly, while during dry periods the draft on the reservoir is likely to be heavy and the inflow small. Prudence will dictate that the operator lean towards keeping on hand a generous supply at all times, and carrying over large volumes from one season to the next so as to avoid starting the new season with a low reservoir.

WORK NOW CONTEMPLATED IS OF LIMITED SCOPE

The present construction program covers only the dam and flood control features, the work being carried out by the War Department. Hans Kramer, M. Am. Soc. C.E., Captain, Corps of Engineers, U. S. Army, is the district engineer in general charge. It is expected that the contract for the construction of the concrete dam will be let during the summer of 1936.

Developments at the Conchas site are being watched with more than usual interest by the sparse local population of this arid section, to whom water supply and prosperity are synonymous. Engineers inclined to spend their vacation in a car will find operations at the dam worthy of a visit. Besides offering much that is of technical interest, this project has a setting of natural beauty in the high plateau country, with its sharply drawn prismatic horizon lines and turquoise skies, that is fascinating to the lover of the outdoors. The dam site is 63 miles by road northwest of Tucumcari, N.Mex., and 123 miles southeast of Las Vegas, N.Mex.

Pier Foundations for the New Orleans Bridge

Difficult Work Successfully Concluded by Use of Sand Islands for Caissons

By N. F. Helmers

Vice-President, Siems-Helmers, Inc., St. Paul, Minn.

In constructing pier foundations for the New Orleans Bridge across the Mississippi, opened in December 1935, the "sand-island" method of sinking open-dredged caissons, first used on the Suisun Bay Bridge, has again been proved advantageous. By its use the expected dangers from caisson tipping and blow-ins of the unstable material under the cutting edge were almost entirely eliminated. The work proceeded at a good rate, in spite of the labor unrest at that time and one of the longest periods of high water on record. In a previous article, published in the December 1935 issue of "Civil Engineering," Harry J. Engel, Jun. Am. Soc. C.E., presented some of the features of the pier foundation work. The present paper, abstracted from Mr. Helmer's address delivered April 23, 1936, before the Construction Division at the Hot Springs meeting, describes in detail the methods and equipment employed by the contractor for bringing to a successful conclusion a very difficult and hazardous undertaking.

Completion of the Mississippi River Bridge at New Orleans marked another successful sinking of open-dredged caissons by the sand island method. This method was first used for the Suisun Bay Bridge, built in 1929–1930 for the Southern Pacific Railway between Benicia and Martinez, Calif. The site of the New Orleans Bridge is about 6 miles upstream from the foot of Canal Street. The bridge accommodates a double-track railway and two 18-ft roadways, as shown in Fig. 1. It was built jointly by the State of Louisiana and the Public Belt Railway Commission, with funds loaned by the Reconstruction Finance Corporation.

The main foundation contract covered the building of nine piers. Pier A, constructed behind the levee on the west bank of the river, was founded in a caisson sunk to El. −115 below mean Gulf level. As it was built on land, no sand island was required. Piers 1, 2, 3, and 4, the main river piers, were sunk through sand islands to El. −170, in water varying in depth from 77 to 40 ft below mean Gulf level. Pier 5, on the edge of the east bank of the river, was sunk to El. −80, while Piers B, C, and D on the east bank were built in shallow open cofferdams on timber piling.

The material underlying the bed of the Mississippi at New Orleans consists of silt, sand, and clay to unknown depths. As the river bed was highly unstable and easily eroded, loosely woven willow mattresses 250 ft wide and varying in length up to 450 ft were sunk with riprap at the site of each of the five river piers to protect the sites from scour.

Upon completion of the willow mats, rings of timber falsework bents 25 ft wide, having inside diameters of 125 ft for Piers 1 and 2 and 115 ft for Piers 3 and 4, were built, forming circular working platforms. Douglas fir piling, varying in length from 110 ft at Pier 4 to 135 ft at Pier 1, was required to set the working platforms at El. +22, which was considered safe from flooding. The piling was driven by a floating pile driver. Two revolving derricks, which handled all dredging, form work, and concrete, were placed on extensions at opposite sides of the falsework ring.

Piers 3 and 4, having caissons 53 by 92 ft in plan and containing 15 dredging wells, required revolving derricks with 85-ft booms; while Piers 1 and 2, 65 by 102 ft in plan, also containing 15 dredging wells, required revolving derricks with 100-ft booms, with a capacity of 12 tons at an 85-ft radius. A boiler plant for supplying steam to the revolving derricks, electric generators, and pumps was installed on a third extension, thus making the operation at each pier largely self-contained.

Constructing the Sand Islands

Following completion of the falsework, the erection of the bottomless steel shells to retain the sand islands was begun. These shells were 122 ft in diameter for Piers 1 and 2, 111 ft in diameter for Piers 3 and 4, and varied in thickness from $^1/_2$ to $^{11}/_{16}$ in. They were assembled in rings, each made up of curved steel plates, 30 ft long, reinforced with angles. The rings were 10 ft high with the exception of the bottom ones, which were 5 ft in depth, and the next two above, which were each $2^1/_2$ ft in depth. The three short rings were introduced to permit the salvaging and re-use of the largest possible amount of shell after the work on the caisson had been completed.

By the use of floating derrick barges, the shell was assembled in sections 30 ft in height and was supported during erection by twelve 24-in. needle beams supported on the falsework [Fig. 2(*a*)]. As each 30-ft section of shell was completed, it was lowered into the water by 12 winches mounted on hoist frames set up around the inner rim of the falsework. After the weight of the shell had been transferred to the hoists, the needle beam supports were removed and the shell was lowered 30 ft. The shell weight was then transferred to needle beams at the platform deck level, and another 30-ft section was erected. This process was continued until the steel shell was seated on the mattress at the bottom of the river and extended to a safe height above water level.

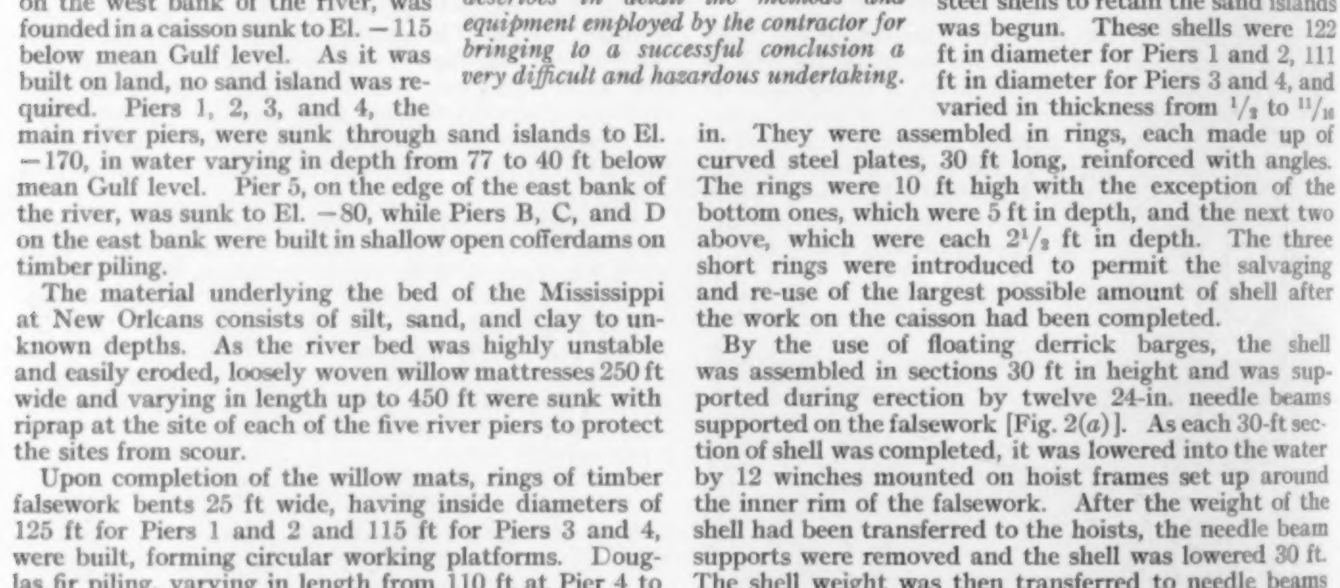


Fig. 1. New Orleans Bridge—Cross-Section of Through Spans, and Elevation from Downstream

At Piers 1 and 2 the shells were 100 ft high and at Piers 3 and 4 they were 70 ft high.

Following the sinking of the steel shell, the willow mattress was cut around the inside perimeter of the shell, using a special cutting chisel 24 in. wide attached to a 100-ft pile and operated by a steam hammer. The central portion of the mattress was then removed with clamshell buckets. Next, the river bottom was dredged inside the shell to allow the latter to sink about 5 ft further, and riprap was placed around the outside to prevent scour. The shell was then filled with sand to a safe distance above the water level, as shown in Fig. 2 (*b*), during which operation it settled not more than 5 ft.

THE CAISSONS WERE SUNK BY EXCAVATING THROUGH THE DREDGING WELLS
View Showing Dredging in Progress at Pier 4

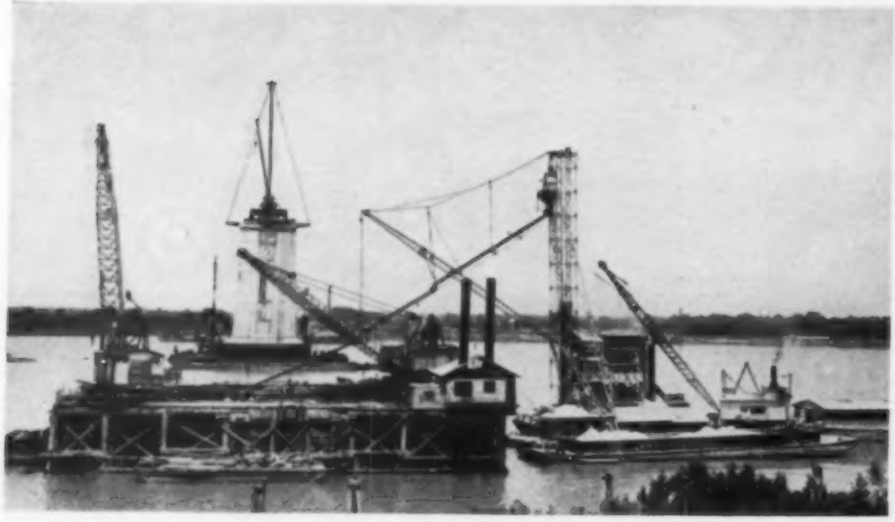
Sand for filling was dredged about one mile upstream from the bridge site, near the Southern Pacific Railway ferry slip, at a point where the railway company found it necessary to dredge to maintain a channel. Dredging was done with a pump barge, originally built as a jetting unit to supply 7,200 gal of water per min at 150-lb pressure to lubricating jets built into the walls of the caissons. By building a dredge ladder, on which was mounted a sand-ejector, and by pumping the mixture of sand and water through a flume into cargo-box barges, it was possible to deliver sand at the pier location faster than the two derricks, mounted on the pier falsework, could place the sand in the shells with 3 cu yd buckets.

On the island thus formed, the steel cutting-edge of the caisson was erected. Steel forms set over the cutting edge formed the rectangular caisson into which the first 10-ft lift of concrete was poured. Twenty feet of caisson was formed and poured before sinking operations were started. Then the caisson was sunk by excavating through the dredging wells with either 2- or 3-cu yd clamshell buckets, depending on the size of the well. The concrete caisson sank by gravity as the sand was removed from beneath it, and when it had been lowered 20 ft, the steel forms were again assembled and another 10-ft lift was added. This operation of alternate concreting and sinking was continued until the caisson was 135 ft high and had been sunk until the top was about 17 ft above mean Gulf level. As the U. S. War Department would not permit the top of the caisson, when in final position, to extend above El. −33, it was necessary to build a 50-ft internally braced, removable cofferdam on top of the caisson to permit it to be sunk to the required bottom elevation of −170. This condition is shown diagrammatically in Fig. 2 (*c*).

WEAVING THE WILLOW MATTRESS FOR PIER 3

The removable timber cofferdam was composed of 12 by 12-in. and 8 by 12-in. timbers, drift-bolted and caulked, and was made in sections that could be handled easily by the derricks. These timber sections were securely anchored to the concrete by hook rods extending down from the top, so arranged that they could be unhooked from the top to release the sections after the pier had been carried up above water level.

After the caisson had been sunk through the island about 70 ft, it was found necessary, before each 10-ft drop, to remove a part of the island to reduce skin friction and to allow the caisson to follow the digging. The only time it was found



POURING CONCRETE INSIDE GRANITE FACING OF PIER 1
100-Ft Construction Tower on Barge at Right

necessary to excavate more than 6 ft below the interior cross walls of the caisson and 2 ft below the outside walls, was when sinking through a stratum of clay. Such strata never exceeded 25 ft in depth. During the sinking operation, it was found necessary to pump water continuously into the caisson with an 8-in. pump to keep the water level the same inside as outside, thus minimizing the risk of building up hydrostatic pressure that might cause blow-ins through the unstable material on the river bottom.

After the final elevation of −170 was reached, the walls of the caisson were washed down, and any material under the cross walls was jetted away by dropping jets down wells 8 in. in diameter, spaced about 3 ft on centers, in both inner and outer walls. Then the tremie concrete seal was placed to a depth of not less than 20 ft, completing the seal in each well before proceeding to the next. Figure 3 shows the seal in place.

A matter of utmost importance was the accurate location of the piers in plan and vertical alignment. The specifications stated that the final position of the caisson should not vary from its designed position more than 1 ft for each 100 ft of caisson depth below mean Gulf level. The actual distances of the centers of the six caisson piers from the plan locations were as shown in the accompanying Table I.

Placing the seals involved the pouring of 3,400 cu yd of concrete through tremie pipes 10-in. in diameter and 198 ft long. Three of these pipes with a 2-cu yd hopper were placed in each of the three center wells, and as quickly as a seal was brought to grade, the pipe was moved, thus entailing no delay in moving pipe from well to well.

Unwatering of the cofferdam down to the top of the concrete was not begun until ten days after the seal was completed, and only a negligible amount of leakage developed through the timber cofferdam, although the unbalanced head exceeded 45 ft. Two steam pumps, running intermittently about 3 hours out of every 24, were required to remove the leakage.

The dredging wells were not filled with concrete but were left open and flooded in order to reduce the weight on the foundation. The pier shaft was carried on a concrete distributing block, and the outside wells were covered with timber. In constructing the distributing block, the main strut members of the cofferdam were left in place and buried in the concrete up to El. −7. Subsequently they were cut off flush with the concrete surface and the load transferred to the concrete with temporary struts wedged in place. In the pier shaft above El. −5, the granite facing was built up to the bottom of each successive set of struts, the concrete poured, temporary bracing placed against the finished pier, and each set of struts entirely removed.

TABLE I. VARIATION OF PIER CENTERS FROM PLAN LOCATIONS

PIER	VARIATION FROM PLAN LOCATION	PIER	VARIATION FROM PLAN LOCATION
A	0.27 ft	3	0.40 ft
1	1.03 ft	4	0.45 ft
2	0.46 ft	5	0.63 ft

When the pier work was above the water level, the cofferdam was flooded, the tie-down rods disconnected, and the cofferdam allowed to float up, when it was removed and used on another pier.

DIVERS LOOSEN BOLTS TO SALVAGE STEEL SHELLS

In order to re-use the steel shell, it was removed as soon as the caisson seal was in place. Two divers were sent down inside the shell to unbolt it at the lowest ring that they could reach. To facilitate this operation, special lug bolts had been used, and the bolt holes were slotted so that the diver could knock out the bolts as soon as they were loosened.

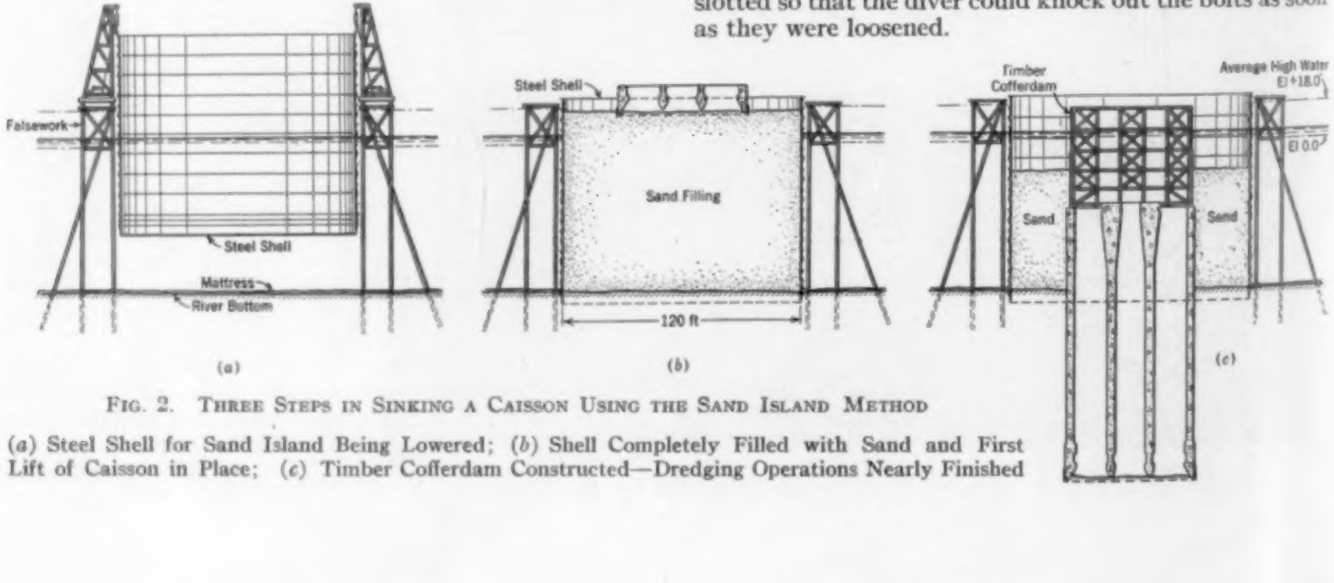


FIG. 2. THREE STEPS IN SINKING A CAISSON USING THE SAND ISLAND METHOD

(*a*) Steel Shell for Sand Island Being Lowered; (*b*) Shell Completely Filled with Sand and First Lift of Caisson in Place; (*c*) Timber Cofferdam Constructed—Dredging Operations Nearly Finished

The steel shell for the sand island was removed by reversing the sinking operations, the hoist frames being reset on the falsework and used to raise the shell from the bottom. Actual dismantling was done with floating derricks, for the derricks on the falsework could not work to advantage with the hoist frames in place. Also, the sequence of operations required that the derricks be removed to another pier as soon as the caisson was sealed. Before the steel shell was raised, the enclosed area on the river bottom from which the protective mattress had been removed at the start of the operation was covered with a blanket of riprap stone to minimize the possibility of scour close to the piers.

BUILDING PIER SUPERSTRUCTURE

The steel forms, reinforcing steel, and concrete for the pier shafts, which were carried to a height of 145 ft above mean Gulf level, were handled by an 85-ft-boom. A frame derrick mounted on a 100-ft steel tower, the tower in turn being mounted on two 20 by 60-ft timber barges. With the exception of the boiler plants and revolving derricks mounted on the falsework, most of the equipment was floating, the largest single unit being the concrete plant. This consisted of an all-steel electric-welded barge, 40 ft by 125 ft by 8 ft 6 in., on which was mounted two 2-cu yd capacity, steam-driven concrete mixers, served by automatic weighing batchers. The aggregate bin was a two-compartment 400-ton bin. The bulk cement bin had a capacity of 300 bbl and was equipped with an automatic feeding and weighing device.

The mixers discharged into a 4-cu yd hopper, which in turn discharged into a 2-cu yd hoist bucket sunk in a well below the deck of the barge at the base of the 120-ft tower. All the concrete for the river piers was distributed by hoisting it up the 120-ft tower and chuting it into the forms. Concrete was delivered for the land piers from the floating plant by 2-cu yd bottom-dump buckets mounted on rail cars run out to the ends of the construction trestle at the water's edge on both the east and the west banks of the river. The average output of this plant was 95 cu yd of concrete per hr for the 120,000 cu yd of concrete poured, with a maximum output, while pouring the seals, of 120 cu yd per hr.

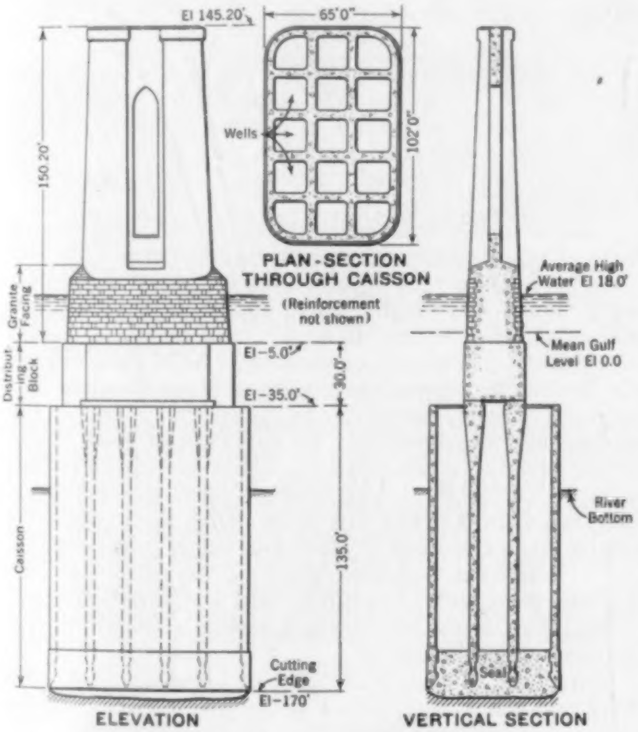


FIG. 3. PIER 1 OF THE NEW ORLEANS BRIDGE
Elevation, Plan-Section Through Caisson, and Vertical Section

Sand and gravel were transferred from barges tied alongside the concrete plant to the batching bins by a revolving derrick equipped with a 3-cu yd clamshell bucket and mounted on the rear end of the concrete-plant barge. Bulk cement was conveyed to the cement bin by a pneumatic unloader from 1,500-bbl barges.

SETTING FORMS FOR SHAFT OF PIER 3 WITH 100-FT TOWER DERRICK

The air required for the cement unloader was supplied by a 300-ft steam-driven compressor, and the electric current by a 100-kw steam-driven turbine generator. Steam was furnished to all the equipment by two 215-hp oil-fired locomotive boilers. Three Diesel tugs, ranging from 60 to 250 hp each, handled all the towing.

Although spur tracks were constructed from trunk-line railroads to both east and west banks of the river, the contractor's shops, yard, and office were located on the east bank because of its ease of access from New Orleans and also because most of the labor came from that city or its immediate vicinity. By the continuation of the east-bank spur track over the top of the levee and the construction of a 900-ft trestle and dock, a direct connection was made between the yard and the river. Two locomotive cranes operating from the yard out onto the dock transferred all materials to barges, which distributed them to the various piers.

RAPID PROGRESS MADE IN CONSTRUCTION WORK DESPITE AN UNPRECEDENTED PERIOD OF HIGH WATER

Although a tentative contract was given the contractor on September 15, 1931, difficulties of financing delayed the actual award until December 30, 1932. The substructure was completed and accepted on November 21, 1934. In spite of the difficulties encountered due to high water, rapid progress was maintained throughout the job, which proved that the time spent making thorough studies of plant, equipment, and sequence of operations helped to eliminate errors in the accomplishment of actual construction work. The rapid rate of progress using the sand-island method was best illustrated at Pier 2, where the total elapsed time, from the day the driving and framing of the falsework ring was started until the seal was completed, was 135 days.

Modjeski, Masters and Case, Inc., were the designing and supervising engineers and Moran and Proctor were the consulting engineers on the foundations. C. Glennon Melville, M. Am. Soc. C.E., was resident engineer for Modjeski, Masters and Case, Inc., at the bridge site. For Siems-Helmers, Inc., the work was handled under the direction of N. F. Helmers, vice-president, with J. M. Kellogg as general manager and C. E. Ryan as field superintendent.

Sanitation in the Mississippi Valley

Some Recent Developments in Malaria Control, Water Works, and Sewage Treatment

In addition to the better-known spheres of water supply and sewage disposal, the sanitary engineer within the past two decades has entered the field of malaria control. This aspect of sanitation is of particular importance in the lower Mississippi Valley, where constant heat and numerous shallow bodies of water favor the breeding of anopheline mosquitoes, which transmit the malaria parasite. All three of the articles which follow are abstracted from papers delivered April 23, 1936, before the Sanitary Engineering Division at the Hot Springs Meeting.

Malaria is on the increase, says Mr. LePrince, not only because old breeding places are left unmolested, but also because new ones are constantly being created inadvertently in the development of engineering projects. It appears that the British have taken a leaf from American experience in building the Panama Canal, and have forged ahead with malaria control in their colonies. The need for a concerted drive in this country is pressing, Mr. LePrince points out, and sanitary engineers should take the lead.

Some recent improvements of importance in the production of good water are described by Mr. Burdick in the second article of the symposium. The use of mechanical devices to aid flocculation and the installation of facilities for better cleansing of sand through a surface wash are quite recent. In the past five years effective elimination of tastes and odors has been obtained through treatment with activated carbon. In addition, a large number of municipalities are installing equipment for water softening.

In his paper on the two sewage treatment plants recently installed by the City of Hot Springs, Mr. Filby describes problems typical of many American municipalities today. Stream pollution is becoming an increasingly serious problem, to the solution of which government and state health authorities are devoting their concerted efforts. Fortunately the day is passing when cities and towns in thickly populated sections can legally discharge large quantities of raw sewage into the nearest watercourse, disregarding the effect upon downstream communities.

Malaria—A Challenge to Engineers

By J. A. LePrince

Senior Sanitary Engineer, U. S. Public Health Service, Memphis, Tenn.

In 1878 a civil engineering graduate who had studied medicine and entered the U. S. Public Health Service was detailed for duty in combating the historic epidemic of yellow fever at Memphis. This engineer, by astounding deductive reasoning, established the incubation period of the fever parasite within the body of the mosquito years before it was definitely demonstrated that yellow fever was an insect-borne disease.

Had it not been for this brilliant discovery of Dr. Henry Rose Carter, the experiments at Havana on the transmission of yellow fever by the stegomyia mosquito might easily have been abandoned after the first negative results—and we might still be having seasonal shot-gun quarantines in place of week-end golf parties throughout the Mid-South. This same man also was largely responsible for our present federal quarantine regulations, designed to safeguard health with a minimum of interference with normal activities. He also took an important part in the sanitation work on the Isthmus of Panama (1904–1913), and then in 1913, he started on his own initiative with no funds other than traveling expenses, to determine the extent of the malaria menace in the Mid-South and the possibilities of control.

Malaria Control Work, 1913–1917

Up to that time, no state or county in our country had appropriated so much as a cent for the control of malaria, or for studying the possibilities of such control. Yet in that year it was conservatively estimated that the annual economic loss caused by the disease in this country exceeded $100,000,000—and most of it was preventable. In 1913 Carter was requested to appear before a congressional committee, and soon afterward an annual appropriation of $17,000 was made for malaria investigations. Out of that apparently insignificant appropriation came results of decided economic importance to the commercial, financial, manufacturing, transportation, and farming interests of 14 states in the "malaria belt."

Field investigations and studies of the reservoirs of hydro-electric plants were conducted between 1914 and 1917. The data thus obtained made it possible to enact state laws and regulations prescribing inexpensive methods for preventing such lakes from becoming sources of explosive outbreaks of malaria. As a consequence, the hydro-electric interests were able to eliminate one source of costly lawsuits by property owners. The studies also demonstrated to the various state health departments how this disease could be controlled in rural sections. Manufacturing interests were shown that an investment in malaria control measures would decidedly improve the efficiency of labor and thereby increase output. Assistance was also given to the educational departments of states, counties, and towns so that rural populations could be instructed as to malaria and the methods of combating it.

When the World War came on, many cantonments were necessarily established in the malaria belt. In the choice of sites, apparently little or no consideration was given to the prevalence of malaria or the possible influence of the topography on the sick rate. In fact, some of the most unhealthful camp sites of the Spanish-American War were reoccupied. As Dr. Carter said, "You could not find better locations for explosive outbreaks of malaria had you spent weeks searching for them."

DOING AWAY WITH A HEALTH HAZARD ON A SOUTHERN GOLF COURSE
Drainage Has Eliminated a Breeding Place for Mosquitoes, and a Permanent Ditch Lining Makes Periodic Cleaning, Regrading, and Larvicide Treatment Unnecessary

The situation was serious, and it was up to the engineers to remedy it. Malaria control work was new to them. The five field men of the U. S. Public Health Service Malaria Investigations Division taught the newly employed engineers how to proceed, and the work done by those engineers is a credit to the profession. If we compare the records of the World War camps with those of camps at the same sites during the Spanish-American War, we find that the sanitary engineering activities accomplished worth-while results; the malaria sick rate was but one-half of one per cent what it had been in the previous period.

After the War, the state health departments undertook the task of malaria control, and drainage for that purpose is now largely under the direction of their sanitary engineering divisions.

MALARIA IS INCREASINGLY PREVALENT

Unfortunately we do not yet know precisely the extent of the problem of malaria control. No machinery exists for effectively collecting data on the prevalence of malaria in the localities where the disease does most damage. Some doctors report their cases and others do not, just as their limited spare time permits—but of course they see only a portion of the existing cases.

The *Statistical Abstract of the United States*, however, reports about 5,000 deaths for the year 1933, corresponding to a million cases of malaria, most of which occurred in the southern states. Since then malaria has been decidedly on the increase in the South; in some states the sick rate doubled in the last three years. In a recent school survey, blood smears from 150,000 children were examined, and 5 per cent were positive. In many schools the rate was between 10 and 60 per cent and in a few schools it was as high as 95 per cent.

What should be of most interest to civil engineers in regard to the distribution of this disease is that in New Mexico, and in the low-rainfall areas of some other states, where malaria has been unknown for the past fifty years, it is now fairly well established and on the increase by leaps and bounds. And every bit of it in such localities has been built into existence unwittingly by the engineering profession. As irrigated areas are extended so is the malaria belt enlarged—and by the work of engineers who ignore the sanitary aspects of their projects.

MALARIA CONTROL IS AN ENGINEERING PROBLEM

Until relatively recently, the medical profession has been divided as to the proper method of attacking malaria. During the construction of the Panama Canal a strong and determined effort was made on the Isthmus to control it by administering quinine, but the scheme was found impracticable, and was abandoned. The distribution of the drug was too costly—and too uncertain, because most people do not like its taste and its effect. Unfortunately this large-scale experiment and failure, and the later success at Panama with other methods, were insufficiently advertised. As a consequence many doctors for a long time continued to look on medical treatment as the answer. Today, however, they nearly all see the wisdom of attacking the disease by attacking the mosquito which carries it.

It is unfortunate that the medical and engineering professions of this country are not as well posted on what was done at Panama in applied sanitation as are these professions in Great Britain and some other countries. These others at once applied what had been learned at Panama, and are still doing so more than we are. The best description of the sanitary work done at Panama was written by an Englishman, Dr. Malcolm Watson, and is entitled *Rural Sanitation in the Tropics*. In what percentage of the libraries of our engineering schools or medical schools can this book be found? How many

engineers ever heard of it? Watson saw that what was done in Panama in 1905 should be done elsewhere, and he at once interested the large colonial plantation companies of Great Britain in this idea. It was an enormous task, but he succeeded—and the plantations made increased profits thereby.

The engineers of this country have not yet engaged in any concerted activity of this sort. In small towns, and in the suburbs of larger towns, we have hardly begun to exclude the disease-carrying mosquito by engineering methods. Yet our taxpayers spend about $25,000,000 a year for screens, little realizing how large a part of this outlay is practically wasted, so far as malaria control is concerned. The amazing part of it is that Sir Ronald Ross, the man who first found that the malaria parasite was conveyed by one family of mosquitoes (Anopheles), complained because the British were so slow in getting malaria control work started—yet they commenced it on a large scale some thirty years before we did, and they got many of their ideas from our work on the Panama Canal.

Most of us probably do not yet grasp the fact that the control of malaria is an engineering problem. However, engineers are beginning to give the matter the serious consideration it deserves. An excellent plan for malaria control has been drawn up for the territory included in the Tennessee Valley Authority project and much research and exploratory work are already being done there to develop better, quicker, and more economical methods. That research has already resulted in the planning for a new method of procedure as far away as the Mexican border.

During the past three years, more progress has been made in the Mid-South in minor drainage accomplished by the engineering profession with federal funds for the purpose of mosquito control, than had been done previously since the first American colony was founded. In this period the Bureau of Entomology constructed nearly 6,000 miles of drainage ditches for mosquito control, affecting adjacent populations estimated at 8,000,000. Much of this work was done in the Mississippi Valley. Also, on federal drainage projects directed by the Malaria Investigations Section of the U. S. Public Health Service, an average of 40,000 men were employed from July 1, 1934, to June 30, 1935. Up to the latter date, 16,000 miles of ditches had been installed and about one-fifth of the population of 16 states benefited.

In this connection, it should be mentioned that nature is always competing with man when he arranges to destroy completely any form of life. For example, a tree falling across an outlet stream may cause silting that will destroy the value of an elaborate system of drainage in a relatively few months. During 1935, many health workers became alarmed at the possibility that these recently constructed ditches might not be properly maintained, and that in a few years much of their value might be lost. I believe, however, that a closer voluntary coordination of the governmental agencies involved will keep that from happening. Moreover, new methods of treating ditch bottoms and ditch banks so that the cost of maintenance will be less than in the past, will undoubtedly be developed.

NEW JERSEY'S PROGRAM FOR MOSQUITO CONTROL

It would appear appropriate in the malaria belt to coordinate the efforts of the conservation groups now functioning so that the patrol work required for economic clearing and maintenance of ditches can be shared by the state health departments and the CCC.

In New Jersey, which has a state mosquito extermination association composed of volunteer workers, there appears to be very little difficulty in obtaining adequate funds for continuous drainage and drainage maintenance. There we find political interference completely absent from mosquito-control activities. Each county does its own work, and each project appropriation must have the approval of the director of the State Agricultural Experimental Station.

A careful analysis of the value of this work in the formerly mosquito-ridden coastal counties of the state has been made by Dr. T. T. Headlee, state entomologist. In it he compares the actual increase of tax valuations with what would have taken place had the pestiferous mosquitoes (non-malarial species) not been brought under control. The mosquito density there used to control property values.

The ratios of tax valuations in 1900 to the valuations in 1930 are:

Where mosquito work was done	1:11.39
Remaining counties of the state, where little or no work was done	1:6.84
The whole state	1:7.18

Six million dollars was spent by the counties of the State of New Jersey in these thirty years for mosquito work, and the increase in tax valuation was over $671,000,000. The people of New Jersey are making a profit by mosquito elimination, while we of the southland still pay out millions of dollars for the privilege of being sick.

It should be pointed out (1) that this success originated through a state appropriation of $10,000 for entomological research in reference to the state's mosquito problem and possibilities of control; (2) that the numerous members of the State Federation of Women's Clubs of New Jersey have been perpetually on the lookout that there might be not even a tendency for politics to creep into the work; (3) that adequate county funds are available and are closely watched by county mosquito-extermination commissions, composed of volunteer workers who are paid in mosquito freedom, and not in cash; and (4) that each county commission keeps the public fully advised as to what is going on, and what each dollar of its money is spent for.

INSUFFICIENT APPROPRIATIONS HAMPER WORK

In our work to control the malaria mosquito in the South, the state commissioner of health has to do all the fighting alone, and too frequently does not have the solid, continuous, interested support of an organized group of prominent business men or organized women workers on the qui vive to keep things going in the right direction.

One stumbling block to progress in the southland is the variation in annual appropriations for this work. Not infrequently the annual economic loss due to malaria in a single county exceeds the state appropriation for control measures for all the counties; it is not unusual for the malaria losses in a county to be as much as a quarter to a third of the total county taxes collected. For instance, Georgia has a state sanitary engineer who is on his toes looking for new and better means of driving malaria out of his state, and misses no opportunity to further this end. But last year in his state only $9,000 was appropriated by nine counties for drug control of malaria; a total of $30,000 was provided by three counties for drainage machines and tools for WPA work, and $2,000 was allowed for travel of epidemiologists largely engaged in drug control, which is essential. In the same year the twelve coastal counties of the New Jersey Mosquito

Extermination Association spent $275,600 of county funds. Even in Utah, one county alone spent about $14,000 of local funds in 1935 for the control of pestiferous mosquitoes.

An emergency situation is facing us in the South. The sources of anopheles mosquitoes must be permanently eliminated. Of course, since the public looks to the doctor to preserve health, unquestionably it is best that all anti-malaria activities should come under the direction of the state health departments and the directors of full-time county health units. But we must awake to the fact that it is absolutely necessary for sanitary engineers to take the lead in this work. If they will do their part in the war against insect-borne disease in the Mid-South, there is no reason why this section should not become one of the most healthful parts of the country.

Developments in Water Works Construction

By Charles B. Burdick

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THE Mississippi Valley and the Mid-South together contain a third of the cities of the United States over 100,000 in population, and nearly one-half of those exceeding 200,000. The varieties of water supply in use in this area embrace practically every type now extant. Progress knows no geographical lines, and recent developments in this region parallel those elsewhere in the United States.

The municipal water engineer captures water wherever it can be had at the least cost. He develops a naturally pure water if he can; but this is difficult to do now, even in sparsely settled areas. If it is dirty he cleans it with filters. If germ-laden, he sterilizes it with chlorine. If too highly mineralized after percolation through the ground, he softens it. If it smells or tastes badly, he treats it with activated carbon.

Classification of Water Supply Sources

Of 94 cities in the continental United States exceeding 100,000 in population, 33 (35 per cent) lie within the Mississippi Valley and the Mid-South. Classified as to source of supply they are as follows:

	No.	Percentage
Surface sources only	19	58
Ground sources only	9	27
Combined surface and ground sources	5	15

Surface supplies may be subdivided as follows:

Surface sources, filtered	18 of 19
Filtered sources, softened	4 of 18
Surface sources requiring impounding reservoirs	6 of 19

According to the 1930 census, out of 122,775,046 people in the continental United States, 68,954,823 are listed as urban dwellers. This urban population has grown from 28.6 per cent of the total in 1880 to 56.2 per cent of the total in 1930.

Appearance Is an Important Aid Toward Future Usefulness
Entrance to East Filters at Louisville, Ky.

In the year 1930 there were 1,208 cities of more than 8,000 inhabitants, totaling 60,333,452, or 49.1 per cent of the entire population of the continental United States, and 88 per cent of the total urban population. The Mississippi Valley and the Mid-South, although more thinly settled per square mile than some other parts of the country, have a fair proportion of the smaller towns and villages, and the great majority of these are served by public water supplies.

Water-works problems and developments in the smaller towns are generally solved more easily than in large centers of population. However, the expenditure per capita is about the same in each case, and therefore the problems with which even the smaller water supplies are concerned require careful study and the application of correct engineering and economic principles. This is particularly important in view of the fact that from 50 to 60 per cent of the cost of water is generally included in the fixed

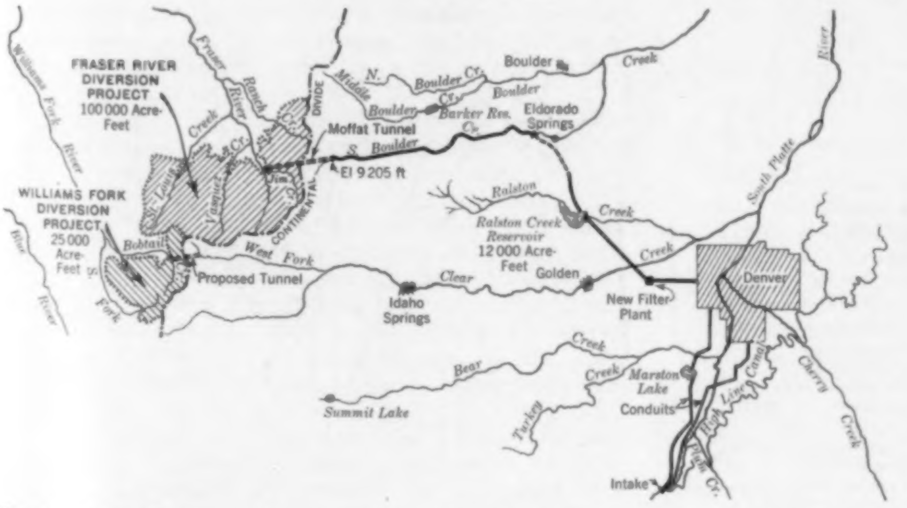


Fig. 1. Fraser River and Williams Fork Water Diversion Projects, City of Denver

charges on the investments. To provide water at least cost requires a definite program which must keep pace with growth. No program can be permanent that does not utilize the best sources for water supply and the proper means for their development.

Between 1880 and 1930 the growth of municipalities was great, but during the past six years of financial depression it has been very slight. Several factors are tending to decentralize population at the present time. However, the increasing demands of the public for better water and better service, a greater uniformity in the habits of the people and in their hours of work, and the ease of financing construction in the last year or two have all tended to promote the construction of municipal water works. At the present time it approaches, if it does not exceed, the normal rate for new construction, principally on account of large projects for improved sources of supply. But expenditures for extension of service to new customers are much below the average.

INTERIOR OF FILTRATION AND SOFTENING PLANT, CEDAR RAPIDS, IA.
Filters Are in Alcoves to Right and Left of the Operating Gallery

Large projects under way at the present time include the $219,000,000 Colorado River Aqueduct for the Metropolitan Water District of Southern California, which will bring water from the Colorado River to serve Los Angeles and vicinity; the $8,000,000 program at Denver, Colo., embracing the development and storage of the Fraser River supply, its transmission across the continental divide, and its filtration and distribution in Denver; the $15,250,000 project at Chicago for the Dever intake crib and Cermak pumping station; the $4,850,000 filtration plant for Milwaukee; and the $3,000,000 rehabilitation program for filtration at Cincinnati. Projects recently completed or under way include Tunnel No. 2 of the New York water supply, costing $56,800,000; and the Quabbin Reservoir and aqueduct for the Metropolitan Water District of Massachusetts, costing $65,000,000.

The accompanying map, Fig. 1, shows the water resources of the city of Denver. The present sources, which all lie on the east side of the continental divide, total about 71,000 acre-ft per year. The Fraser River diversion project will bring the water of that river to the east slope through the pilot bore of the Moffat Tunnel. Work now under way includes bringing 56,000 acre-ft of this water to Denver via Boulder Creek, Ralston Creek reservoir and conduit, and the new West Side filter plant four miles west of Denver. From this point water will be distributed by gravity to high-level districts in Denver to which it is now pumped.

The most significant developments in water works construction have related to improvements in methods for securing and purifying water, and for providing other facilities for better service. Mention has been made of the more exacting requirements of the consumers in recent years. This has led to a greater use of water per capita and materially higher seasonal, daily, and hourly peaks of use. The most significant of these developments will now be reviewed.

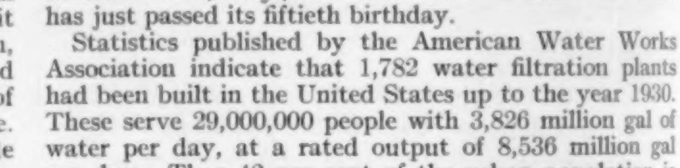
INCREASING USE OF FILTERED WATER

The most important developments, and those having the greatest effects upon health and general welfare, have resulted from filtration and from chlorine sterilization.

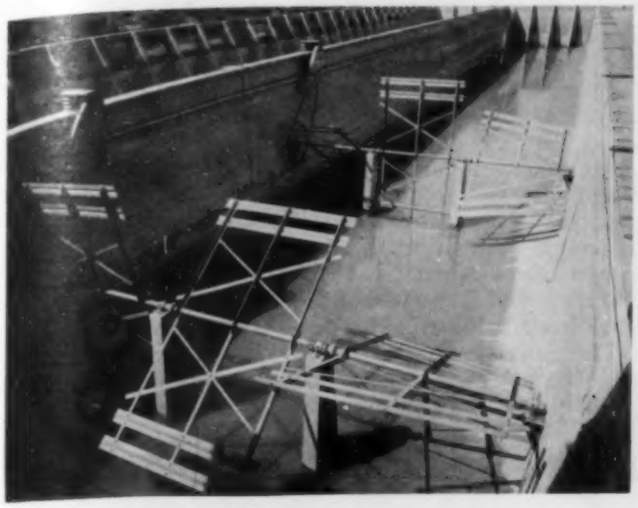
Although man has probably attempted to purify his drinking water since the beginning of civilization, it was not until 1829 that the first slow sand filter plant was built, for the city of London, England. This process showed very remarkable results in eliminating such water-borne diseases as cholera and typhoid fever, and it was adopted by a number of European cities. The development in water purification in the United States dates from the installation of the first mechanical filter at Somerville, N.J., in 1882. The mechanical filter has just passed its fiftieth birthday.

Statistics published by the American Water Works Association indicate that 1,782 water filtration plants had been built in the United States up to the year 1930. These serve 29,000,000 people with 3,826 million gal of water per day, at a rated output of 8,536 million gal per day. Thus 42 per cent of the urban population is supplied with filtered water, or 50 per cent if we exclude

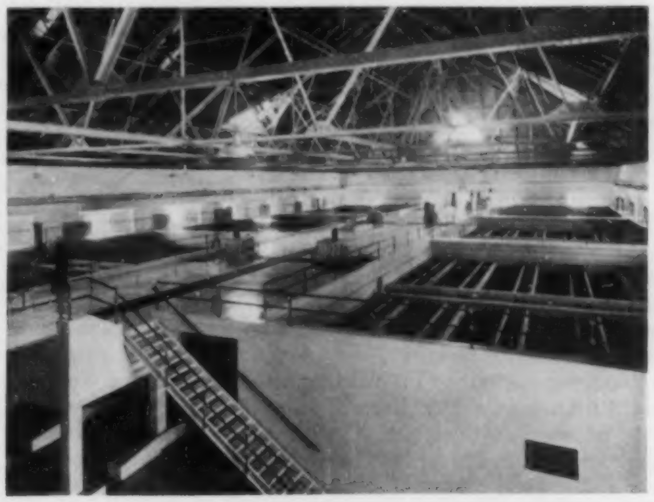
TABLE I. SURFACE WASH DATA



ITEM	KENOSHA	RACINE	BAYLIS	MILWAUKEE
Sketch				
General data:				
Filter equipment	8–1.0 mgd	8–1.5 mgd	....	32–6 mgd
Experience	2 years	1 year	....	Proposed
Lateral spacing	14 and 22 in.	23 in.	Nozzles with four 1/4-in. jets 38 deg with horizontal	3 ft –6 3/4 in.
Jets above sand	2 in.	Flush	4 in.	2 in.
Surface wash alone:				
Surface wash rise	3.2 in.	1.74 in.	7.0 in.	5.08 in.
Average jet velocity	29.3 ft per sec	32 ft per sec	24.0 ft per sec	28.5 ft per sec
Maximum jet velocity	33.8 ft per sec	33 ft per sec	......	28.8 ft per sec
Minimum jet velocity	23.9 ft per sec	31 ft per sec	......	28.1 ft per sec
24-in. backwash plus surface wash:				
Surface wash rise	......	......	......	4.50 in.
Average jet velocity	......	......	......	25.2 ft per sec
Maximum jet velocity	......	......	......	25.5 ft per sec
Minimum jet velocity	......	......	......	24.8 ft per sec



Flocculators Installed in Louisville Basin Illustrate a Recent Advance in Water-Works Practice



New South Filter Units at Louisville Have a Capacity of 6 Mgd Each

the two largest cities, New York and Chicago, which still serve unfiltered water. The supplies that remain unfiltered are principally developed from sources which are more or less remote from habitation and relatively clean. Practically all river water supplies are filtered. The water of the Ohio River between Pittsburgh and Cairo is re-used 22 times. Within the Mississippi Valley and the Mid-South, 95 per cent of the surface supplies for cities of over 100,000 population are filtered.

This tremendous growth in water filtration came about only after ten or fifteen years of experimentation and partial failure, during which time it was demonstrated that the secret of success lay in pretreatment of the water through adequate coagulation and sedimentation. The fundamental principles of sand filtration and filter washing by a reverse current of water have remained practically unchanged from the first installation. Some important refinements of these processes have taken place in recent years.

The great development in water filtration followed a general recognition by the public of the beneficial effects of the process. This was largely brought about through the application of chemistry and bacteriology to the analysis of water, and a number of experimental tests made on full-scale plants by qualified sanitarians between 1891 and 1900. These experiments, which included extensive tests at Providence, R.I., Louisville, Ky., Cincinnati, and New Orleans, demonstrated beyond doubt that clean and healthful water could be produced by filtering such extremely turbid waters as those of the Ohio and Mississippi rivers.

Prior to 1902 filters were inclosed in circular receptacles of steel or wood and were necessarily comparatively small in size. Following the introduction of reinforced concrete in this country, the filtration plant at Little Falls, N.J., utilized this material for rectangular filter beds. The Little Falls filter beds had a capacity of 1 mgd each.

One of the photographs shows reinforced concrete filter units of 6 mgd each, installed at Louisville, Ky. Such large sizes have become practicable through the use of reinforced concrete. The filters shown in this view were installed in 1932 to replace similar filter beds constructed of steel plates.

The size of filter units has grown to 6.3 mgd per bed in the 200-mgd plant now under construction for Milwaukee. This probably represents the maximum economical unit size, which is limited by the pipe connections for purposes of washing.

The rate of filtration has changed but little during the past forty years. A rate of 2 gal per sq ft per min is still considered standard, although filters equipped with adequate pipes give successful results up to 3 gal. This excess capacity is generally considered desirable to care for overload, making unnecessary the installation of reserve filter beds. Plants handling clear water, as in

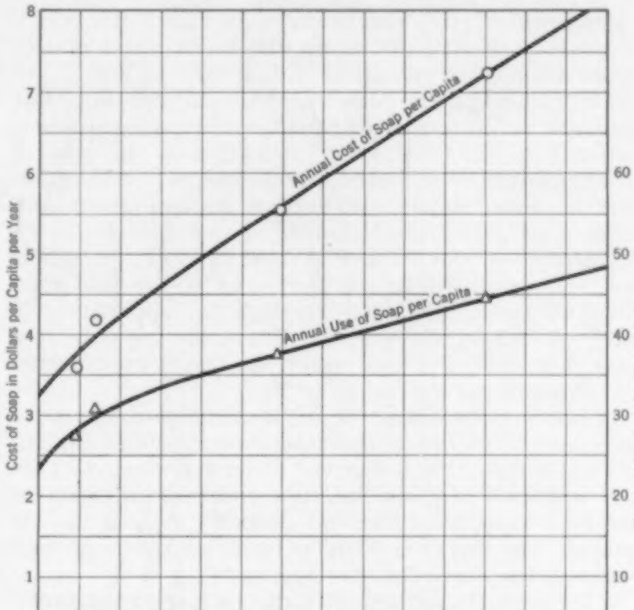


Fig. 2. Influence of Water Hardness on Use of Soap
From a Study of Conditions in Superior, Bloomington, Champaign-Urbana, and Chicago Heights

the case of softening installations for well waters, are commonly rated at 3 gal per sq ft per min.

The sketches and tabular data in Table I indicate recent methods for assisting in the washing of mechanical filters through the application of a surface wash to supplement the usual upward-flow wash. The columns illustrate the methods now in use at Kenosha and Racine, Wis., experimental data in connection with the city of Chicago's filtration investigations, and the method proposed in the 200-mgd filter plant being built at Milwaukee.

As in the case of filter washing, preparation of the water has gone through a gradual development. Adequate periods of sedimentation now follow chemical treatment, and devices have been developed to improve flocculation after chemical dosage and before sedimentation.

ELIMINATING TASTES AND ODORS

An important forward step taken within the past five years is the elimination of tastes and odors through treatment of the water with activated carbon. Formerly aeration was used for this purpose, but while helpful in some cases, it had little or no effect in others. The activated carbon process appears to be equally effective whether the material is used in powdered form previous to sedimentation, or in granular form as a filter following sand filtration. The advantage of the powdered carbon lies in ease of application with a minimum of capital expenditure. Its disadvantage lies in the necessity for a variable amount, depending upon the degree and kind of taste and odor, with very heavy dosages in exceptional cases. Granular carbon filters are self-regulating. Like a zeolite used in water softening, they have a definite capacity for the absorption of tastes and odors which is independent of the rate at which the work is done. Thus they are relatively foolproof when once installed. However, the cost of installation and of periodic regeneration is a disadvantage.

The municipal water works at Oshkosh, Wis., takes its supply from Lake Winnebago, a very large and shallow arm of Lake Michigan. This supports a heavy growth of algae, which gives rise to excessive tastes and odors. To properly remove the latter, the water was found to require an average powdered-carbon dose of 160 lb per million gallons, with peaks as high as 350 lb. The plant now in process of construction includes capacious powdered-carbon feeders for application at the inlet of the sedimentation basins of the existing water filtration plant, improved mixing and flocculating equipment, and granular carbon filters following the sand filters, with which a rate of upward flow of 3 gal per sq ft per min is used. The plant will be operated so as to eliminate practically all tastes and odors through the application of powdered carbon, the granular filters serving only as a factor of safety. For this reason the filters are expected to have a more or less indefinite life.

An important element in the treatment of water for tastes and odors lies in the ability to recognize the objectionable condition before the water is delivered to the plant and to determine the taste and odor intensity so that feed equipment can be properly regulated. At Oshkosh, the Baylis method of analysis has been used to express the degree of odor and taste.

At the present time activated carbon is used constantly or intermittently, as required, in about 400 water-works systems. Its use in most of these was begun within the last two or three years.

WATER-SOFTENING PLANTS PROVE GOOD INVESTMENTS

In line with the public demand for better water-works service, an increasing number of municipalities are recognizing the advantages of serving soft water to consumers. The statistics of 1930 indicate that 152 municipal softening plants are in operation within the United States. The majority of these are in the Mississippi Valley, where hard water generally prevails. Twelve per cent of the large cities in this region are thus supplied. In the ordinary filtration plant the softening process can be instituted with a nominal expenditure for equipment and an increase in operating expenses of between 1 and 3 cents per thousand gallons treated.

The advantages of soft water have long been recognized, but the general public has been slow to realize that the benefits warrant the increase in water rates that is generally necessary. It is easy to compute the pounds of soap that would be saved by softening a hard water, but it is not so easy to figure the gallons actually used for washing and other purposes where soft water is desirable. The greater part of any municipal supply is used for other purposes. The best argument for a municipal softening plant is the satisfaction that consumers show when a good plant has been installed. No town that has adopted municipal softening has ever gone back to hard water.

The State Water Survey of Illinois, in cooperation with the school of commerce at the state university, has recently made an investigation that greatly assists in

UTILITY AND BEAUTY ARE COMBINED IN THE WATER WORKS AT DES MOINES, IOWA

evaluating the benefits of a softened supply. This study is summarized in the proceedings of the American Water Works Association in a paper by H. W. Hudson and A. M. Buswell, the principal results of which are shown in Fig. 2. This study is based upon an investigation of soap sales in four Midwestern towns in which the municipal water varies in total hardness from 45 to 555 ppm. The information in regard to purchases of soap per capita was obtained from local merchants. The study indicates that the saving in local expenditures for soap is equivalent to approximately 72 cents per capita per year for each 100 ppm of hardness removed. On this basis, the saving in soap alone will pay the entire cost of softening in many of the municipal plants that have been built, even including fixed charges on the investment in filters and appurtenances. Other monetary savings are so well known that municipal water softening will pay its way in any city having hard water.

Many recent water-works improvements are steps in a progressive program. Such programs have resulted from the growing recognition that with an increasing demand a system of water works can only attain success if good water is furnished at the least possible cost; and that economy can be secured only if construction expenditures are made a reasonable time in advance of need. For this a well-formulated building program is essential.

It is now practicable to build filtration plants that will probably last for an indefinite period, and therefore it is desirable to construct buildings of a permanent type. Appearance is believed to be an important element in guaranteeing a long future usefulness. One of the photographs shows the attractive Cedar Rapids filtration and

softening plant and electric pumping station. The filters are contained within the low superstructure in the foreground. The higher part of the building is for the storage of chemicals. Coagulants and softening reagents are unloaded and stored by the vacuum process.

The Des Moines pumping station has a beautiful park surrounding it and is one of the most attractive spots in the city. The buildings were constructed on low ground with floor levels well above high water in the Raccoon River. To avoid excessive filling, borrow pits that had supplied material for roads were beautified under the direction of a landscape architect, at a large saving compared to the cost of hauling in fill from considerable distances.

The average cost of water is probably less than 2 cents per capita per day, a very small sum when compared with other family expenditures. This prime necessity of life is worth whatever it costs.

The Hot Springs Sewage Treatment Plants

By E. L. Filby

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HOT Springs, Ark., on June 1, 1936, completed a PWA improvement program which involved the construction of two sewage treatment plants and some 6,600 ft of intercepting sanitary sewer at a cost of approximately $300,000. The small Gulpha Plant and the uptown sewers were completed and in operation as of April 1, 1936, and the larger South Plant is now in operation.

Practically all of the city is served by sanitary sewers, which are separate from the storm drainage system. All but about 500 acres is served by a sewer laid in the valley of Hot Springs Creek and discharging into the creek just south of the city limits. The Oaklawn district, including the race-track area, also empties into this main sewer at the point of discharge. The remainder of the city is tributary to Gulpha Creek on the east. Untreated sewage has also been discharged into Little Gulpha Creek, a wet-weather branch.

For many years the Arkansas State Board of Health, through M. Z. Blair, state sanitary engineer, has known of the nuisances being created in Hot Springs and Gulpha creeks, and has exerted every effort to secure abatement. In the meantime, although the city and park administrations proudly proclaimed, "We bathe the world," and invited the sick and ailing to make use of the beneficial hot water, nothing was done to correct the nuisance. Finally the Public Works Administration came into being and a concerted effort was made by government and state authorities to remedy stream pollution.

In the interim the Arkansas Power and Light Company had developed two hydro-electric projects on the Ouachita River, creating Lakes Hamilton and Catherine immediately south of the city. Overnight these lakes became the centers of summer colonies. It was soon realized by the public that sewage coming down Gulpha Creek was polluting Lake Catherine, and that the large flow of sewage down Hot Springs Creek was creating a very serious condition in the lower reaches of Lake Hamilton. A non-partisan sewage disposal commission was appointed; studies and estimates were made; and a budget of $300,772 was set up. After ascertaining that it was not financially feasible to bring the Gulpha outfall over into the Hot Springs Creek system, it was tentatively decided to build two treatment plants of the Imhoff tank, trickling-filter type located as shown in Fig. 1.

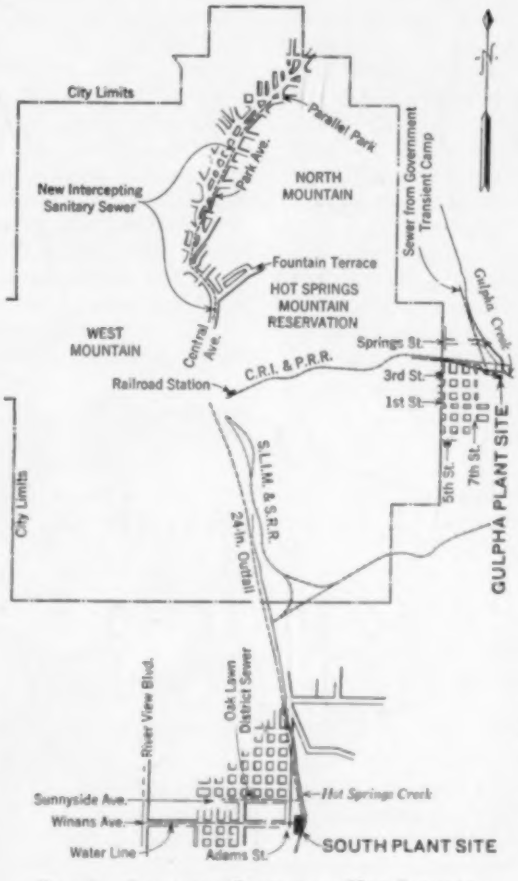


Fig. 1. Location Sketch of Hot Springs Sewage Treatment Plants

As the bathhouses on the government reservation and the government hospitals were contributing a considerable volume of hot dilute wastes, the federal government agreed to pay 27$^1/_2$ per cent of the cost of construction over and above the PWA grant provided that it should not be charged for any service or use of the system, or for repairs, alterations, or maintenance. The government also reserved the right to inspect plant operation at any time and to request betterment of maintenance and operation should that be considered necessary. The National Park Service then made a grant of $82,000; PWA granted $43,000; and the City of Hot Springs floated a general obligation bond issue of $175,000, making a total of $300,000 available. The sewage disposal committee's selection of the firm of Black and Veatch to design and supervise construction of the project received the approval of the National Park Service.

After preliminary studies had revealed the desirability of the use of the activated sludge process at one of the plants, the city felt justified in asking the Arkansas Power and Light Company, which would benefit somewhat by having its lakes protected, for a donation of power from its nearby high-tension lines. The result was an agreement providing that the company should run a power line to the South Plant and credit the city with $25,000 for power to be consumed at the plant, such power to be charged at the rate of 1 cent per kw-hr.

A preliminary study of local conditions was made, covering the physical and chemical characteristics of the sewage, flow variations and volumes, topography of available plant sites, possibilities of esthetic objections, extent of treatment necessary, methods of treatment to be recommended, and route of new uptown sewers. It was apparent that any combination of the outfalls was financially impossible. An inspection of the location of the two outfalls indicated excellent gradients and a very rapid response to climatic conditions.

AERATION TANKS AT SOUTH PLANT, WITH PRIMARY CLARIFIERS IN THE FOREGROUND

DESIGN DATA FOR THE SOUTH PLANT

Practically all the city, including Bathhouse Row, the hotels, and the Oaklawn Race-Track area, are served by the 24-in. Hot Springs Creek outfall, discharging just south of the city limits at the north end of the city dump. The sewage is a mixture of used city water, human waste, and hot bathhouse water, with no industrial wastes present. Analyses and field tests indicated a very low sulfate content. In city water, 8.4 ppm of sulfate was present, and in bathhouse water, 7.8 ppm. Hydrogen sulfide tests were negative. Composite samples indicated a pH of 7.0; a 5-day B.O.D. of from 220 to 320 ppm; and average settleable solids of 6.0 ml in 15 min, 6.5 ml in 30 min, and little further settling in one or two hours. Temperatures ranged from 85 to 97 F.

We concluded that we had a moderately strong, hot, fresh domestic sewage to treat. Ten days' observation of dry-weather flows indicated a total flow of from 880,000 to 1,102,000 gal, with maximum rates of from 2,140,000 to 2,860,000 gal per day, and a daily average of 3 hr of flow above the 2 mgd rate. Maximum flows were sharply defined between 7 and 9 a.m., with a secondary small peak at 2 p.m. A study of bathhouse records indicated a July average of 1,200 baths per day using 233 gal of hot spring water per bath, or a daily total of about 280,000 gal of bath water. In a peak month such as March, the expectation was about 4,000 daily baths, or 932,000 gal of bath water. This peak may be materially reduced when the hot spring water is sold to the bathhouses on a metered basis rather than, as now, on a basis of "per bath given."

A study of census figures was made and a curve drawn for future growth, indicating a 1935 normal population of 23,000 and a 1950 population of 27,500. Observations of the trend of development and character of improved property indicated that 20,000 residents, 400 hospital patients, and 6,600 tourists—a total of 27,000—would be contributory to the South Plant in 1935, while for the Gulpha Plant the total was 4,000. For 1950 it was expected that these figures would be 32,100 and 5,200, respectively.

Design was based on an average day with a 22,600 connected population load at 75 gal per capita, and 466,000 gal of bath water, giving a total of 2,166,000 gal. For a day in a peak month we estimated a connected population load yielding 2,300,000 gal and a bathhouse load of 930,000 gal, or a total of 3.23 mgd. Infiltration is excessive in wet weather and very low in dry weather. Accordingly the policy was adopted of treating the dry-weather flow and by-passing excess flows to the streams. We used 3 mgd as a design basis for the South Plant. The policy of overloading the plant during peak flows will be adopted and all flows in excess of 4 mgd will be by-passed or given primary treatment only.

The site for the plant was the only one available beyond the junction of the Oaklawn district outfall and the Hot Springs Creek outfall. Owing to legal and construction difficulties it was not possible to relocate the Oaklawn district outfall. Topographical considerations and costs prohibited extension of the outfall south beyond the dump. It was also considered that the nearby property, the value of which had been depreciated for years by the dump, would not be further affected by a sewage treatment plant. Shale-rock excavation was indicated, with a hard dike-like stratum extending across the site. No residences are nearby other than the small-pox "pest-house."

No discharge measurements of Hot Springs Creek were available. However, the stream is very erratic, responding almost instantaneously to rainfall on the watershed. A boulder-strewn bed afforded excellent re-aeration, and algae growths above the sewer indicated only slight pollution. It was deemed advisable from the outset to provide complete treatment for dry-weather sewage flows and to use either trickling filters or the activated sludge process. After a comparative study of construction costs, operating expense, freedom

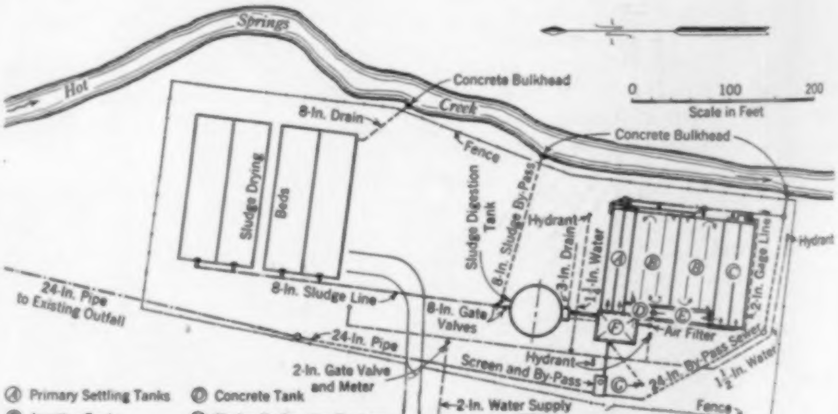


FIG. 2. GENERAL LAYOUT OF THE SOUTH PLANT

from odors, and adaptability to the site, the use of activated sludge was decided upon.

GENERAL FEATURES OF THE SOUTH PLANT

The South Plant (Fig. 2) is of the activated sludge type, designed to handle 3 mgd of sewage from a population of 32,100. A motor-driven sewage screen of the comminutor type, with $^3/_8$-in. slotted openings, has been installed in a concrete structure which serves as a screen and by-pass chamber. Flows in excess of 4 mgd are automatically by-passed and the entire flow may be by-passed at this point if desired. The screen is operated by a 3-hp float-controlled motor, and there is a hand-cleaned bar screen with 1-in. openings for emergency use.

A settling period of 1.8 hr has been provided for in two rectangular tanks equipped with sludge collectors and skum skimmers of the straight-line type. The average settling rate is 1,415 gal per sq ft of tank surface per day, and the length of the overflow weir is 6.7 ft per million gallons of daily capacity.

Six aeration tanks of the Manchester type with a total capacity equal to 5.4 hr average flow, plus an allowance of 25 per cent for returned activated sludge, have been provided. Air is diffused by alundum plates set in receptacles at the bottom of the tanks. These plates cover a total of 910 sq ft, or approximately 11 per cent of the tank surface.

Duplicate final settling tanks with a total capacity of 2 hr of average flow, plus an allowance of 25 per cent for returned sludge, have been constructed. These tanks are equipped with sludge collectors of the straight-line type, and with an overflow weir having a length of 44 ft per million gallons of daily capacity. The average settling rate is 880 gal per sq ft of tank surface per day.

The re-aeration tank has a capacity of approximately 4 hr activated sludge production, and is so located that it may be filled by gravity from the final settling tank. A tank of the fill-and-draw type, with a capacity of approximately $1^1/_2$ hr production of activated sludge, has been provided for the purpose of concentrating waste sludge previous to digestion. The sludge digester is of the floating-cover type, with a capacity of 2 cu ft per

Digesting Tank and Sludge Beds, Gulpha Plant

capita, and is equipped for gas collection. Hot-water coils have been installed should it be found necessary in the future to provide temperature control of digestion. The digested sludge will be air-dried on sand beds of the conventional type. An allowance of $^3/_4$ sq ft per capita has been made.

The various pumps, air blowers, recording devices, and other facilities have been located in a brick-and-concrete building which also houses the office and laboratory. The plant is served by city water, and power is obtained from the Arkansas Power and Light Company. The plant site is enclosed by a 7-ft non-climbable galvanized-wire fence, and flood-lighted for night operation. Sewage flow will be measured by means of a 24-in. Cippoletti weir and recording meter.

TRICKLING FILTER DECIDED ON FOR GULPHA PLANT

The Gulpha Plant serves only about 500 acres inside the city limits, but the point of discharge is such that a

Concrete Piers and Steel Straps Were Used to Hold the 14-In. Pipe in Place in the Archway

Hot Springs Creek Flows Under the Main Thoroughfare Through This 18-Ft Stone Archway

considerable acreage outside, near the government free tourist camp, can some day be connected to it. This system had practically normal domestic sewage, and only a small proportion of the houses were connected. The B.O.D. samples reflected a low night flow, the 18-hr day composites giving a 5-day B.O.D. of from 185 to 450 ppm. The pH average 7.1, and settleable solids were 7.0 ml in 15 min, with very little increase thereafter. Temperatures were not taken as there is very little, if any, bathhouse water entering this system.

The outfall runs east along the Rock Island Railroad and discharges into Little Gulpha Creek about 500 ft above its junction with Gulpha Creek. Sewage flow measurements were made as at the South Plant, and total flows were found to range from 80,000 to 118,000 gal per day, with a maximum recorded rate of 342,000. The minimum rate was below 20,000 gal per day. The rate of flow exceeded 200,000 gal per day for an average of 4 hr daily. With an estimated population of 2,000 served, this sewage flow approximates 51 gal per capita. For a future connected population of 4,200, we have allowed 60 gal per capita and set the design basis at the rate of 300,000 gal. Before the plant was built, the federal government located a transient camp for 1,200 people near its free tourist camp and piped the sewage down to the Gulpha outfall, thus practically reaching the future loading expected. An extension of this transient-camp sewer will serve the tourist camp.

As at the South Plant, complete treatment was considered necessary. In view of the small flows and the prospect of part-time operation, we selected a separate sludge-digestion, trickling-filter, final-settling type plant, with chlorination for odor control or sterilization. Automatic time-controlled devices are provided, and the chlorine is automatically fed at any one of three possible points. Space and facilities for doubling the size of the

plant were provided at the site, and if the transient camp is enlarged, it may be necessary to use heavy chlorination and increased filter loadings.

GENERAL FEATURES OF THE GULPHA PLANT

The Gulpha Plant is of the sprinkling-filter type, designed to handle 0.3 mgd of strictly sanitary sewage from a population of 5,200. A 10-in. revolving screen of the comminutor type has been located near a by-pass

CONSTRUCTING UPTOWN SEWER NEAR THE ARLINGTON HOTEL

chamber so arranged that flows in excess of 400,000 gal per day are automatically by-passed. A settling period of 1.2 hr has been provided in a rectangular tank equipped with sludge collectors and scum skimmers of the straight-line type. The skimmings are conducted to a grease trap so arranged that it will act as an overflow and by-pass in the event that the dosing siphon fails to operate. The average settling rate in this tank is 1,250 gal per sq ft of tank surface, and a weir length of 26 ft per million gallons of daily capacity has been provided.

The trickling filter is of the revolving distributor type, 108 ft in diameter and 6.5 ft deep. The filter rock consists of 5.5 ft of crushed novaculite, a local, high-silica rock with a 12-in. top dressing of crushed Hot Springs granite. Provision is made for flooding and for chlorination.

The final settling tank is of the central inlet and peripheral overflow type, and has an average detention period of two hours. The average settling rate is approximately 700 gal per sq ft of tank surface per day, and the overflow-weir length is 72 ft, or approximately 240 ft per million gallons of daily capacity. Sludge from this plant unit is pumped back into the influent line of the primary tank by means of a motor-driven unit controlled through an adjustable time-switch.

By means of a chlorinator with a capacity of 36 lb per day, having automatic time-clock control, chlorine solution may be applied at the plant inlet, at the trickling filter inlet, and at the outlet of the final settling tank.

In a single tank of the floating-cover type, 2 cu ft of digestion capacity has been provided. This tank is equipped for gas collection and temperature control if found necessary. Two underdrained sand beds with an area of approximately 0.5 sq ft per capita have been constructed.

Plant equipment is housed in a brick-and-concrete building, conveniently located with respect to the various plant units. Laboratory facilities have not been included because all tests will be run at the South Plant. The plant site is served by city water, and power is obtained from the local company. A 7-ft non-climbable fence surrounds the site, which is being landscaped.

CONSTRUCTING THE UPTOWN SEWERS

One section of the project consisted of laying a relief sanitary sewer from the end of Bathhouse Row up Park and Central avenues, a distance of approximately 6,800 ft. The existing 6-in. sanitary sewer had been laid to varying grade on a very poor alignment. No field notes, profiles, or records were available. Records of the location of gas and water mains were likewise not to be had. Storm-water archways were known to be in the street, but it was not known where they were located, or at what depth.

In the early days, Hot Springs Creek flowed down the main thoroughfare and Bathhouse Row faced the creek. As the city grew, it was decided to enclose the creek in an archway, to fill in the sides, and to use the top of the archway as a street. Accordingly an 18-ft archway was built of native rock. The creek bed was not paved except in a few places. Today only a few people realize that there is a creek flowing under the main business street of the city. It was finally decided to start at a cast-iron sewer in the Hot Springs Creek archway under Central Avenue and follow it for a time; then to leave the arched structure and proceed under the gutters and under the grass parkway and sidewalks. This part of the work was the most interesting from a construction standpoint, as it was necessary literally to feel our way, and to be constantly on the alert for necessary changes in grade and alignment to miss serious obstructions.

Inside the large Hot Springs Creek archway previously mentioned, temperatures up to 120 F were encountered, and vision was limited because of condensation. The contractor installed a cut-off tarpaulin curtain and an exhaust fan so that the men could work more than an hour at a time. The old base of the archway had eroded away and the holes had filled with sludge. Fixing alignment and grade for the 400 ft of 14-in. cast-iron pipe in the archway was difficult. Concrete piers and steel straps were used to hold the pipe in place.

All excavating was done by hand, and the backfill was very thoroughly tamped in place to prevent settling.

Manholes were so close together that a clear line of sight from manhole to manhole was possible throughout. Ground water was not a serious problem anywhere. The old sewer is still in place serving a few residences but the flow has been intercepted in several places and overflow lines have been cut into the new sewer, which averages about 12 in. lower than the old line.

Construction was under the direction of Edward Farmer, assisted by Wendell Wyatt, both Juniors Am. Soc. C.E., from the office of Black and Veatch, and Carl Wilson, inspector. The engineer inspector for PWA was A. M. Lund, M. Am. Soc. C.E., of Little Rock, who was assisted by W. A. Crow. The cooperation of D. A. MacCrea, M. Am. Soc. C.E., engineer examiner of the State Director's office, PWA, Little Rock, was appreciated. City Attorney A. T. Davies represented the City of Hot Springs, and Superintendent T. J. Allen, Jr., of the Hot Springs National Park, represented the Park Service. The construction superintendent for H. A. McGuire, contractors on the South Plant, was A. T. Bodie. On the uptown sewers, Cleveland Smith represented A. C. Kennedy. The contractor for the Gulpha plant was A. C. Jones. The writer had general charge of the project from the preliminary studies through the placing of the plants in operation.

Waterway Versus Rail Transportation

Are the Improvements on the Mississippi Valley Waterway System Economically Justified?

THIRTY-FIVE hundred miles in length, the Mississippi Valley water transportation system embraces the Mississippi between the Gulf and Minneapolis, with a connection to the Great Lakes by way of the Illinois waterway system; the Ohio between Pittsburgh and Cairo; and the Missouri below Kansas City. Expenditures to date for navigation betterments to the system aggregate $500,000,000, and an additional $150,000,000 will be required to complete the work now contemplated. Maintenance, including lock operation, is estimated at $10,000,000 annually. The improvements so far made accommodate a total water-borne traffic of approximately 30,000,000 tons a year on the system, exclusive of materials for improvement works and of commerce on the tributaries.

Few engineering topics have aroused so much difference of opinion as the question of the economic justification of these expenditures. Mr. Putnam takes the affirmative, contingent upon the ability of the Middle West to develop a traffic of 35 billion ton miles a year within the near future. In addition, he views improvements now going on as securing previous investments in the system and perpetuating our "inland coast." Mr. Wonson, on the other hand, questions the economic justification of improving any waterway which requires a large outlay even to permit navigation by a restricted type of craft. The Mississippi Valley system, says Mr. Wonson, should carry such service charges as will enable it to be self-supporting, and in the event that the cost exceeds the revenue, should be retired or operated as a feeder to existing rail facilities.

Members will be interested in the presentation of this timely subject from two different viewpoints. Both articles are abstracts of papers delivered on April 25, 1936, before the Waterways Division at the Hot Springs Meeting of the Society.

Mississippi Valley Water Transportation

By Rufus W. Putnam

Member American Society of Civil Engineers

Director, Chicago Regional Port Commission, Chicago, Ill.

WATER transportation in the Mississippi Valley had its beginning long before the white man came to America. It was the canoe of the explorer and later the keel boat and flat boat of the trader in furs and other commodities that opened up the only great trade routes to the interior available until the middle of the nineteenth century.

Steam navigation was first used on the western rivers about 1810. The boats were of the "packet" type, carrying both freight and passengers, and were operated upstream as well as downstream. With improved transportation, river settlements increased in number and size, trade boomed, and New Orleans became a port of primary importance. Between the years 1840 and 1860, water transportation in the Mississippi Valley was at its height. The first real blow came with the completion of through rail lines between the Middle West and the Atlantic seaboard.

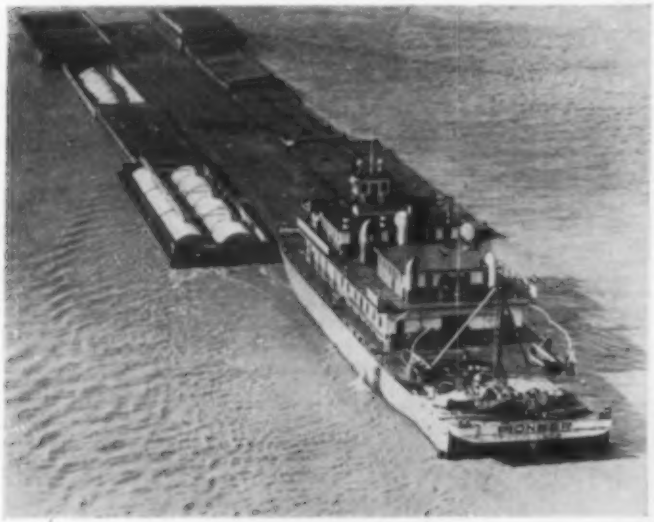
Diesel Towboat of the Inland Waterways Corporation on the Illinois River

During the entire period of almost complete dependence on the rivers, little was done either by public or by private agencies to make them more suitable for navigation. The first comprehensive plan for the improvement of the Mississippi River above New Orleans was not undertaken until 1880. A program for the Ohio River was begun the same year; the canalization of the Monongahela River was started in 1876; improvement work on the Missouri was initiated in 1878; and that on the upper Mississippi in 1872.

The towboat and barge system of river transportation began with the movement of coal downstream on the Ohio River in 1850. By the time these river improvement projects were well established as a matter of national policy, towboat and barge traffic had reached a substantial volume. It was to benefit this coal movement, as well as the shipment of steel from Pittsburgh, that the project for the improvement of the Ohio River by slack-watering was undertaken in 1910.

The principal routes in the Mississippi Valley comprise the Mississippi River as far as Minneapolis, with the connection to the Great Lakes by way of the Illinois waterway system; the Ohio River between Pittsburgh and Cairo; and the Missouri below Kansas City. This system has a total length of about 3,500 miles and will have a depth of at least 9 ft at extreme low water. This depth is now available for over 90 per cent of the time on the Ohio River, the Illinois waterway system, and the Mississippi below St. Louis—a total length of over 2,500 miles. The projects for the upper Mississippi and the lower Missouri should be completed within the next five years.

Including only those portions of flood control works having a direct relation to the betterment of navigation, the total expenditures to date for capital improvements amount to $500,000,000, and approximately $150,000,000 additional will be required to complete these projects. Maintenance, including operation of the locks, has been estimated at $10,000,000 a year.



TOWING ON THE OHIO RIVER
Note the New Type of Tanker at the Left

Extensive facilities have been provided at many places along these rivers for the transfer and storage of freight such as coal, steel, pipe, petroleum products, building materials, cotton, sugar, sisal, bauxite, molasses, grain, and miscellaneous cargo.

WATER TRANSPORTATION EQUIPMENT

The latest reports by the U. S. Department of Commerce indicate that there are approximately 160 towboats of 100 ihp or over in service on the water routes in the Mississippi Valley, and that the aggregate indicated horsepower of these towboats is about 100,000. The same reports show that barges of 100 tons or over have a combined carrying capacity of approximately 1,500,000 tons. The Diesel engine is replacing the steam engine in many instances, the saving in crew and fuel costs offsetting the higher fixed charges. Propulsion units of 1,500 ihp or more are becoming quite common.

Wooden barges were once the vogue, and they continued in extensive use for a great many years. In recent years, however, most of the towboats have been built of steel, and in large towing operations the use of steel barges is practically universal.

Self-propelled barges are a rarity on the Mississippi system, contrary to the practice on canals and waterways in the East. The Federal Barge Line, a division of the Inland Waterways Corporation, which operates on the lower Mississippi, had three in service for several years but their use was discontinued over a year ago. Although they made fast time while navigating, too much time was lost at the terminals.

The traffic carried on this main system of inland waterways has been much greater in recent years than during the period when water routes were the only means of long-distance transport of freight in large quantities. Furthermore, there has been a substantial growth since the improvement projects have been nearing completion. Excluding the traffic on the tributaries, the total water-borne commerce on this system in the year 1915 approximated 15,000,000 tons; it now totals about 30,000,000 tons a year. A large proportion of this movement is over a comparatively short haul. The average haul has been gradually increasing but whether this will continue is problematical.

WATER TRANSPORTATION COSTS

What appears to be a wide variation in the cost of towboats is largely due to differences in size or class of operating machinery. Steam towboats vary roughly from $250 per ihp for boats of from 500 to 1,000 ihp to $200 per ihp for boats of from 1,500 to 2,000 ihp. Towboats using Diesel engines are usually slightly higher in cost. There is also a wide range in the cost of barges, but these may be grouped roughly as follows:

Hopper type	$15 to $20 per ton of cargo capacity
Deck barges	$18 to $25 per ton of cargo capacity
Package freighters . .	$30 to $40 per ton of cargo capacity

Fixed charges, including interest, depreciation, insurance, taxes, and annual overhaul, average around

TERMINAL WAREHOUSE OF THE INLAND WATERWAYS CORPORATION AT BIRMINGHAM, ALA.

18 per cent. Operating costs include wages, food, fuel, lubrication, repairs, and superintendence. Wages vary from $3 to $6 per man per day, and crews from 20 to 30 men. Subsistence costs vary between 55 cents per man per day for the Federal Barge Line (on the lower Mississippi) to $1.10 per man per day in the Chicago district. Steam towboats average about 2,600 ton miles per barrel of fuel oil, and Diesel engines about 4,800 ton miles per barrel. Lubricating costs for steam towboats average approximately 3 mills per ihp for each day of service, while towboats equipped with Diesel engines average about 8 mills per ihp per day for a two-cycle engine and 4 mills for a four-cycle engine.

In addition to the annual overhaul, repairs throughout the season for steam towboats average 3 cents per ihp per day, and for Diesel engine installations about 4 cents per ihp per day. Repairs to barges vary between 1 and 5 per cent of the first cost of the barges. The cost of superintendence will amount annually to from 1 to 2 per cent of the cost of the fleet operated. There are also miscellaneous charges, which amount to 1 cent per ihp per day of service. Steam towboats average 10 ton miles per hp-hr upstream and 17 ton miles per hp-hr downstream.

With all the wealth of written material on the economic

justification of transportation projects, and particularly in view of the excellent papers previously published in TRANSACTIONS, one might think that all points on both sides of the controversy had been covered, but the writer believes he has an approach to the subject sufficiently different to provoke a new line of discussion.

A rough comparison will determine the net tangible cost to the country at large of supporting the existing traffic on the main waterways of the Mississippi Valley. If all the waterway traffic were carried by railroads serving the same points, allowing a cost of $50,000 per mile for the roadway, a capital investment of about $175,000,000 would be involved compared with a cost of $500,000,000 for waterways. The annual traffic handled by waterways is about 5,000,000,000 ton miles, which is equivalent to about 3,600,000,000 ton miles by rail. Transportation of this traffic by rail would cost about $40,000,000, as against $60,500,000 by water.

When improvements now under way are completed, these water transportation routes could easily accommodate an annual traffic of at least 50 billion ton miles, and with the addition of duplicate locks at critical locations, this capacity could be doubled. If a comparison is made on the basis of capacity—in which case the first cost of the railroad roadway required to carry it would be doubled—the costs involved would be approximately $233,000,000 by rail and $167,000,000 by water. In this case the comparison favors water transportation. If the water traffic totaled 35 billion ton miles, the corresponding railroad tonnage would be about 25 billion, approximately the capacity of a single-line road; under those conditions it would cost $155,000,000 by rail and $143,250,000 by water. The tangible economic justification of this large expenditure for waterway development lies, therefore, in the ability of industry and commerce in the Middle West to develop and support water traffic approximating 35 million ton miles a year.

INTANGIBLE VALUES SHOULD ALSO BE CONSIDERED

In a discussion of the intangible effects of the development of water transportation routes in the Mississippi Valley, it is necessary to keep in mind that most of the construction operations in connection with the improvement of these routes have been completed and the expenditures already made. Arguments as to the wisdom of works already completed are somewhat academic, as the money expended cannot be recovered without putting these projects to work.

All the great nations of the world have been developed on the premise that the sea is the base of the system of transportation. By close analogy the interior of a great country may be developed to best advantage by preserving for the use of the general public the free water highways of its great rivers, even at some expense if necessary. The principle involved is identical. In the opinion of the writer, some $20,000,000 a year is a small price for this country to pay if by so doing it accomplishes the multiple purpose of salvaging large expenditures made in previous years, of preventing a violent readjustment in the distribution of industries and population, and of preserving a group of minor "sea bases" located on a secondary coast line 7,000 miles in length.

River Transportation Is Not Cheap

By S. L. WONSON

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WELL into the nineteenth century the rivers of the Mississippi Valley exercised an essential function in our national life. So long as the muscles of men and animals were the only motive power available, river transportation remained inherently superior to any form of land transportation. Consequently certain feelings as to the virtue of river transportation and the necessity for its continuance were impressed on the national consciousness. Such impressions, which persist for some time after their factual basis has passed, are characterized by emphasis upon the emotional rather than the realistic viewpoint.

DECLINE OF THE RIVERS AS FREIGHT CARRIERS

The function of the railroads as freight carriers did not develop immediately. The railroad map of 1840 discloses a complementary relation of the early railroads to the waterways, but the map of 1860 shows a different picture. The shift of traffic from river to rail had started, following the shift in the direction of traffic initiated by the opening of the Erie Canal.

Both the shift of traffic from river to rail and the rapid growth of the country after the Civil War caused the railroad plant to be at times overtaxed, and the situation of the waterways became the concern of various official committees and commissions. All these bodies based the need for inland waterway transportation upon the periodic inadequacy of the railroads and the consequent necessity for additional facilities to meet transportation requirements.

The sudden large increase in transportation needs during the World War again taxed the railroad plant to its limit, and together with the taking over by the United States of transportation on certain waterways in 1918, apparently contributed to the feeling that land transportation was inadequate and must be supplemented by the development of the inland waterways. As the passing of an era came to discount the correctness

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RAILROAD LIFT BRIDGE FOR PASSENGER TRAFFIC AT LITTLE ROCK, ARK., PROVIDES FOR FLOOD CLEARANCE AND RIVER TRAFFIC ON THE ARKANSAS RIVER

of this conclusion, emphasis has shifted to a superior economy claimed for inland waterway transportation.

DO RIVER IMPROVEMENTS FILL A REAL NEED?

Some hold that improved waterways are natural competitors of the railroads and effectively regulate their rates. This theory was advanced as early as 1874. However, the more clear-sighted commentators have recognized the fallacy of this view. In *A Traffic History of the Mississippi River System* (1909), Frank H. Dixon said, "If the purpose is to reduce railway rates, there are more direct and less costly methods of accomplishing this result."

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REFRIGERATOR FREIGHT TERMINAL AT ST. LOUIS ON THE MISSISSIPPI RIVER

The National Waterways Commission, in its first report of 1910, pointed out that expenditures on waterway improvement for the purpose of regulating railroads or reducing rates, are not justified by either reason or experience. The scope of railroad regulation has been so extended and strengthened in recent years as to justify the conclusions of these two authorities.

In view of the foregoing, an attempt to appraise the fundamentals of the situation may be in order. Public necessity requires a transportation service that is adequate, efficient, and economical. There seems to be general agreement that the railroad plant is adequate for present transportation needs and that it will continue to be so for some time to come.

Class 1 rail carriers of the United States transported 2,452 million tons of revenue freight in 1929 and 1,370 million tons in 1934. Transportation on the major rivers of the Mississippi basin amounted to 36 million tons in 1934, and these figures include materials used in river improvement work.

Considering that the railroad plant was not overtaxed in 1929 and that its efficiency will increase, it would appear that the construction, maintenance, and operation of waterways in the Valley is no longer justified on the ground that other agencies of transportation are or will be inadequate in capacity.

RAILROADS AND WATERWAYS NOT ON AN EQUAL FOOTING

From the viewpoint of efficiency, the rail carriers have certain inherent advantages, such as a superior flexibility of service and the power to render continuous transportation without delay or expense for transfer at intermediate points. Other things being equal, the relative efficiency of two or more types of transportation service will be clearly shown by the revealing test of public use.

It is well known, however, that such equality of conditions does not now exist. The rail carriers are subject to restrictive legislation and regulation, while the river carriers are largely free from such restrictions and are further enabled, by acts of government, to offer their services for a charge which does not cover the total cost by a substantial margin. In other words, the users of the service pay a part of the cost and the taxpayers pay the rest.

Broadly speaking, the total cost of rail transportation to the public may be measured by the charge for the service. In 1934 the average charge per ton mile for freight transported by Class 1 rail carriers was 9.8 mills, of which 0.9 mill was directly refunded to the public in the form of taxes, thus reducing this charge to slightly below 9 mills per ton mile. These figures apply substantially to the railroads serving the Valley.

Neither the cost of the river carriers nor their charges for service are a measure of the total cost to the public, as such cost includes public expenditures for river improvements for purposes of navigation, and public expenditures for river terminals.

EXPENDITURES BY THE GOVERNMENT FOR RIVER IMPROVEMENT

Of the cost of river transportation, the part paid by federal taxpayers differs widely for the various rivers of the Mississippi basin. The figures that follow are derived from the annual report of the Chief of Engineers, U. S. Army, for the year 1934, which is the latest for which statistics for both expenditures and traffic have been published. Interest at 3 per cent and current maintenance are used, and no allowance is made for amortization.

The course of the Ohio River parallels the main currents of traffic and it flows through a highly industrialized section in which bulk commodities are found in great quantities. Tonnage on the Ohio exceeds that on the Mississippi. Notwithstanding these favorable factors, federal expenditures, adjusted for circuity (the excess mileage by river over the mileage by rail), amount to 7.8 mills per ton mile of river traffic.

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RAILROAD CONSTRUCTION IN PROGRESS NEAR WASHINGTON, MO. Excavation for New Alignment Along Missouri River

Conditions on the Monongahela are exceptionally favorable to low-cost river carriage. Its tonnage has been larger than that of the Ohio and is now about 76 per cent of the latter. Disregarding circuity, which is slight, the federal contribution to the cost of transporta-

tion on this river is $2^1/_4$ mills per ton mile. Of this tonnage, 83 per cent is coal, moved downstream from mines along the river.

The contribution of the federal taxpayers to the cost of transportation on the Mississippi River between Minneapolis and the mouth of the Ohio is 2.4 cents per ton mile, and maintenance amounts to 1.1 cents per ton mile. These figures disregard circuity, which is not great, and take no account of the fact that more than one-third of the total tonnage is material for river improvement.

Commerce on the Missouri River has always been relatively insignificant, as the natural channel conditions for navigation and the direction of its course above Kansas City are both unfavorable for the needs of traffic. Disregarding circuity and any expenditure on the Fort Peck project, the cost to the Federal taxpayers of river transportation between Sioux City and the mouth of the Missouri is 26 cents per ton mile, and the maintenance cost alone is 5 cents per ton mile. In 1929 more than 99 per cent of the total tonnage was material for river improvement work. In later years, the percentage has been simply stated as "large."

On the lower Mississippi, if anywhere, we should expect to find a large volume of traffic carried at a cost below the possible range of transportation cost by land. Yet the Mississippi Valley Committee of the PWA finds that the cost of improving this section of the river for navigation may be estimated conservatively at \$190,000,000 and that the average annual maintenance is at least \$2,700,000.

This committee states that during the period 1928–1932 the average annual traffic, exclusive of material used in government work and the coastwise and foreign petroleum traffic below Baton Rouge, was about 1,681,000,000 ton miles, and that, allowing for the meandering course of the river, involving distances by water that are some 50 per cent greater than those by rail, the actual public expenditures would be approximately 9 mills per ton mile.

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Missouri Pacific Grain Elevator at St. Louis

THE REVENUE OF WATER CARRIERS

The Inland Waterways Corporation, owned and controlled by the United States, is the dominant common carrier by water in the Valley. Operating the Federal Barge Lines with modern and efficient equipment, its revenue is presumably an approximate measure of the necessary charge for carrier service. In 1934 its revenue was 3.6 mills per ton mile for the upper Mississippi, and 3.4 mills per ton mile for the lower Mississippi. In 1934 the revenues of the corporation were less than its expenses. The balance sheet indicates that this tendency has prevailed since the beginning of operations in 1924.

It therefore appears that $3^1/_2$ or perhaps 4 mills per ton mile should be added to the costs previously mentioned as representing the necessary revenue of the common carrier by river. The costs of private and contact carriers are doubtless less, although the cost of private terminals should be included. Again, the circuity factor should be applied to the ton-mile cost to make it comparable with the cost of rail transportion. On the lower Mississippi, for example, federal expenditures and common carrier revenue produce a ton-mile cost to the public of 14 or 15 mills as against a total cost of 9 or 10 mills for rail carriage.

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Street View of Passenger Station at Little Rock, Ark.
Tracks Are on the Lower Level

THE SO-CALLED INTANGIBLE VALUE OF WATERWAYS

The suggestion is sometimes made that while the existing investment in waterways may not have been wholly wise, this investment should be preserved or "salvaged" by providing for its continued use. No agency of transportation, regardless of investment, should be preserved simply because of past performance. If and when it becomes relatively inefficient, outmoded, and obsolete, the public interest requires that it be retired from use.

Consideration of the essential part formerly played by the waterways of the Valley is not a sound basis for expenditures for the improvement and maintenance of these waterways for transportation purposes.

Public expenditures will have to be repaid, with interest, by taxation. Expenditures which are an exercise of a power of government, rather than of its essential function, should rest upon a basis of economic justification. Otherwise they constitute a levy upon the nation's total consumption of goods and services.

CONCLUSIONS

Projects upon which the cost of federal maintenance exceeds the cost of using other transportation facilities, should be retired or turned over to such local interests as may be able to operate and maintain them on an economic basis.

Projects upon which the cost of federal maintenance is less than the cost of using other available facilities should, in justice to the taxpayers who now support them, carry such service charges as may be equitable.

Additional expenditures should not be made except upon a basis of economic justification. Such justification should take into consideration all costs involved and a realistic appraisal of the traffic to be expected.

Construction Operations at Fort Peck

Natural Obstacles Fail to Check Progress of Federal Public Works Dam Project

By T. B. Larkin

Member American Society of Civil Engineers

Lieutenant Colonel, Corps of Engineers, U. S. Army; District Engineer, Fort Peck District, Fort Peck, Mont.

Scheduled for completion in 1939, work is now well advanced on the Fort Peck Dam project, designed to provide and maintain an 8- to 9-ft channel in the Missouri River east of Sioux City, Iowa. Nearly one-third of the hydraulic fill for the dam has been placed, and it is expected that the diversion tunnels will be completed in time to permit closure of the dam next year. This remarkable progress in building the world's greatest earth dam was facilitated by the use of the most modern construction equipment, including hydraulic pipe-line dredges of unprecedented size, efficient elevating graders, tractors, and trucks. Naturally, the scope of the project has afforded an opportunity for unemployment relief, but only careful planning and determined prosecution of the work throughout the recent severe winters have made possible the continuous employment of not less than 4,000 men since June 1934. This article is abstracted from a paper delivered by Clark Kittrell, Major, Corps of Engineers, on April 23, 1936, before the Construction Division of the Society at its Hot Springs Meeting.

On October 23, 1933, actual construction work began on the Fort Peck project, located on the Missouri River in northeastern Montana. This project has for its primary engineering purpose the improvement of navigation on the Missouri River between Sioux City, Iowa, and St. Louis, Mo. By storing flood water and releasing it during periods of low water, sufficient flow can be assured to maintain an 8- to 9-ft channel for this stretch throughout the navigation season. In addition to the strictly engineering purposes, the Fort Peck project is being constructed as part of the public works program to provide work for the unemployed. Not less than 4,000 persons have been employed at any time since June 1934, and peaks of over 7,100 occurred in both 1934 and 1935. On May 31, 1936, there were 9,199 persons on the pay rolls.

Of all the projects being prosecuted throughout the nation by the U. S. Corps of Army Engineers, Fort Peck is probably the largest and embraces the most varied construction features. Over 40 miles of standard-gage

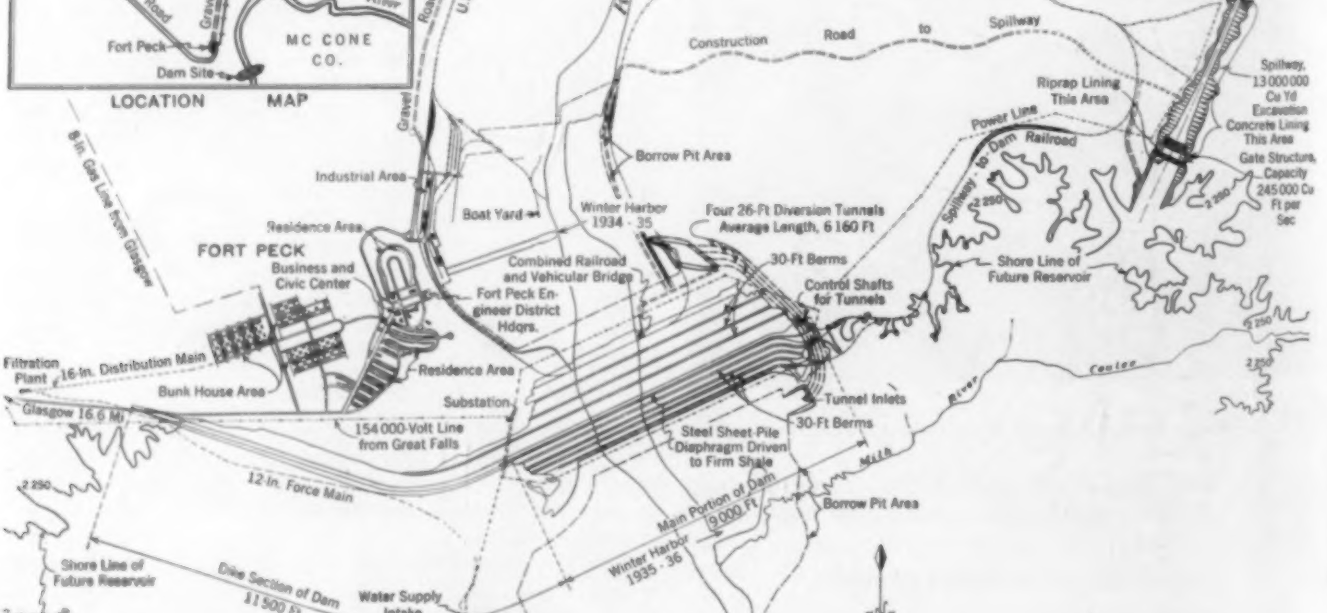


Fig. 1. General Plan of Fort Peck Dam, Showing Construction Features

railroad has been constructed and is being operated. A combined rail and vehicular bridge has been thrown across the Missouri River. Over 6 miles of standard railway trestle has been placed, leading to and enclosing the area of the dam. It has been necessary to build and maintain many miles of paved roads in the town and of construction roads in the working area. To provide power for the dredges, a 50,000-kva, 154,000-v power line, 288 miles in length, has been built from Great Falls, Mont., to the dam site. To place the hydraulic fill of 100,000,000 cu yd, four electric dredging units, unprecedented in size, have been built on the site and placed in service. A complete town has been built, housing 435 families and 3,800 workmen.

AIRPLANE VIEW OF SPILLWAY GATE STRUCTURE, FORT PECK DAM, SEPTEMBER 10, 1935
Showing Gate Structure in the Foreground

The dam, the diversion tunnels, and the spillway all include planning and construction problems of considerable magnitude. There were 125,000,000 cu yd of earth to be moved; 1,200,000 cu yd of concrete to be placed; 24,680 lin ft of 24-ft 8-in. tunnel to be driven and lined; 3,500,000 cu yd of gravel and 1,500,000 cu yd of heavy riprap stone to be placed in the toes and on the slopes of the dam; and 17,000 tons of steel sheet piling to be driven for the cut-off wall. The general plan of the dam is shown in Fig. 1, and a cross-section in Fig. 2.

Wherever it might be located, such a project would present formidable problems and provide valuable experience data. But the Fort Peck project is in sparsely settled Montana, far from centers of population where skilled workmen congregate, and remote from all those facilities so essential to uninterrupted progress. Since the project is a part of the PWA program, speed in starting was essential in order that men might be put to work at the earliest possible date. Improvisation was required. Work had to be pushed regardless of weather conditions; an organization had to be welded together; and men unaccustomed to construction work had to be trained.

AIRPLANE VIEW OF FORT PECK OPERATIONS, LOOKING EAST, NOVEMBER 22, 1935
Note Experimental Dam in Lower Right Foreground

ALL-ROUND USEFULNESS OF THE TRACTOR

It has been necessary at Fort Peck to utilize the most modern machines wherever possible, otherwise the task could hardly have been undertaken. Aside from the dredges, the tractor and the truck have been employed to the greatest extent.

An outstanding illustration of the tractor's usefulness has been given at Fort Peck. Tractors hauled the long poles and stretched the cables for the power line, pulled

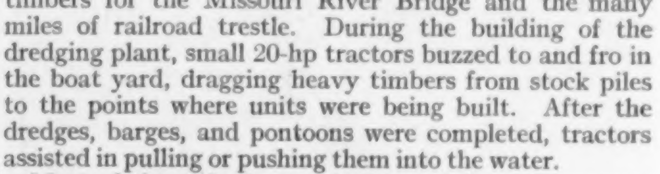


FIG. 2. TYPICAL CROSS-SECTION OF FORT PECK DAM

the graders and 12-cu yd carry-alls for building the roads in the town, and were used to snake piling and timbers for the Missouri River Bridge and the many miles of railroad trestle. During the building of the dredging plant, small 20-hp tractors buzzed to and fro in the boat yard, dragging heavy timbers from stock piles to the points where units were being built. After the dredges, barges, and pontoons were completed, tractors assisted in pulling or pushing them into the water.

Most of the stripping at the base of the dam was accomplished by elevating graders pulled by the latest type of 75-hp Diesel-operated tractors; the latter also proved excellent stump-pullers, aiding materially in clearing operations. Tractors were used on all the railroad grading, the climax being reached when a 90-hp machine pulled two 12-cu yd carry-alls. Tractors operate continually on the beaches of the fill, pulling skids loaded with dredge pipe and construction material.

Numberless smaller jobs have been performed. Trucks are assisted up steep grades and pulled out when they get bogged in mud or sand. Buildings are moved quickly and efficiently. Recently, a single-story, 92 by 38-ft frame structure was skidded over 3,500 ft by six 75-hp machines.

Chains for pulling or bumpers for pushing were the only accessories required for these operations. By

CUT-OFF WALL CONSTRUCTION WITH 196-FT GANTRY CRANE

means of the bulldozer attachment, which can be set for straightaway work or used at an angle in either direction, a machine is available which can grade roads, dig drainage ditches, and move earth, gravel, and boulders over short distances very economically. Bulldozers have been utilized at Fort Peck for all these purposes, but their chief use has been on the construction of the gravel-and-rock toes. Specifications require that the gravel shall be not more than 6 in., nor less than $^1/_2$ in., in diameter. It is brought in by rail in general service cars and dumped from the trestles. Bulldozers were found ideal for moving the gravel the distances required (a maximum of 250 ft from the center line of the trestle), and for keeping the trestle clear for continued dumping. During a period of several months, five or more 75-hp machines were engaged on this work.

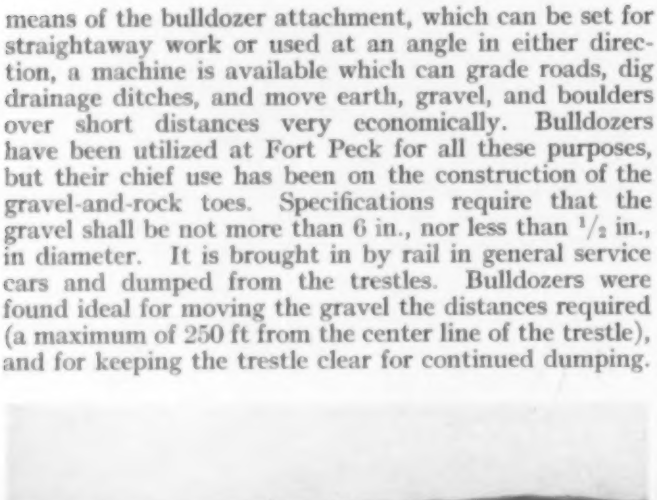
In the summer of 1935 a rock sill was placed under a part of the Missouri River Bridge as a protective measure against floods prior to the closure of the dam, which is scheduled for 1937. Glacial boulders were used, ranging from 20 to 2,000 lb in weight. Air-operated dump cars dropped the rocks from the trestle, and bulldozers moved them to position. On the lower part of the upstream face of the dam, where these glacial boulders are being used for riprap, bulldozers were employed to push them into place. Another novel use for the bulldozer has been found in excavating for the main control shafts of the diversion tunnels. Rectangular pilot shafts, 5 by 7 ft, were driven on the axis of each main shaft from the top of the bluff to the tunnels below. The operation of enlarging the shafts to the necessary 60-ft diameter was then begun at the top. The loosened excavated material was pushed by small bulldozers into the pilot shafts, at the bottom of which were hoppers to catch the muck. From these hoppers the muck was loaded into dump cars and hauled out through the upper tunnel portals.

A small crane, mounted on a tractor and deriving its power directly from the tractor engine, has been found exceptionally useful for handling the 28-in. dredge pipes and doing other relatively small lifting jobs continually required in the field.

TRUCKS AND ELEVATING GRADERS PROVE EFFICIENT

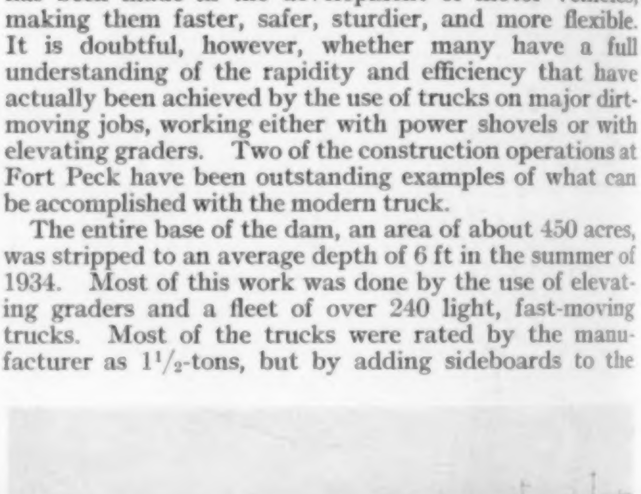
All engineers appreciate the continual progress that has been made in the development of motor vehicles, making them faster, safer, sturdier, and more flexible. It is doubtful, however, whether many have a full understanding of the rapidity and efficiency that have actually been achieved by the use of trucks on major dirt-moving jobs, working either with power shovels or with elevating graders. Two of the construction operations at Fort Peck have been outstanding examples of what can be accomplished with the modern truck.

The entire base of the dam, an area of about 450 acres, was stripped to an average depth of 6 ft in the summer of 1934. Most of this work was done by the use of elevating graders and a fleet of over 240 light, fast-moving trucks. Most of the trucks were rated by the manufacturer as $1^1/_2$-tons, but by adding sideboards to the



GRAVEL AND ROCK FOR DAM TOES IS BROUGHT IN BY RAIL AND DUMPED FROM TRESTLES

Constructing Downstream Toe on West Bank



DRESSING OF GRAVEL TOES WAS DONE WITH BULLDOZERS

Close-Up of the Downstream Toe, West Bank. The Railroad Trestle Now Carries Vehicular Traffic Also

bodies a capacity of 4 cu yd was attained. Dual rear tires provided powerful traction. Continual maintenance of the haul roads by tractor-drawn scrapers made possible average speeds of 25 miles per hour with load and 35 miles per hour on the return trip. The haul roads were sprinkled to lay the dust. Sprinkling was also instrumental in keeping the road surface packed and free from chuck-holes. With the trucks working only in daylight hours (two shifts of 7 hr each), a maximum daily output of 45,000 cu yd was attained, and the entire job of 4,155,956 cu yd was completed in 153 days. This was done with an average haul of over $1^1/_2$ miles!

This stripping operation shrinks considerably in stature when compared with the excavation of 13,000,000 cu yd for the spillway. Here practically all the loading was done by power shovels, most of the excavation consisting of dense, heavy, Bearpaw shale which could not be handled by elevating graders. About 100 high-speed trucks with 6-cu yd bodies formed the bulk of the hauling equipment, although a few units of 8- and 12-cu yd capacity were employed. The haul roads, averaging $1^1/_4$ miles from the shovels to the spoil area, were excellently maintained. None was less than 60 ft in width, and several were 120 ft, with four traffic lanes. Trucks traveled at an average speed of 30 miles per hr when loaded, and faster when empty.

In view of the necessity for night operations, ample illumination was provided not only in the shovel pits but also along the haul roads and spoil areas in order to avoid collisions. Electric flood lights, arranged so as to avoid glare in the truck-driver's eyes, were installed on ordinary telephone poles along the roads and at other critical points. The poles were moved as the scene of operations was shifted. In addition to these provisions, it was necessary to control traffic at intersections. This was done by flagmen in conspicuous positions, who indicated routes and rights of way. At the peak of operations in 1935, over 50,000 cu yd were moved daily, the record day's haul being 58,255 cu yd. Over one million yards were handled during each of several months; the record of 1,431,823 cu yd was set in April 1935.

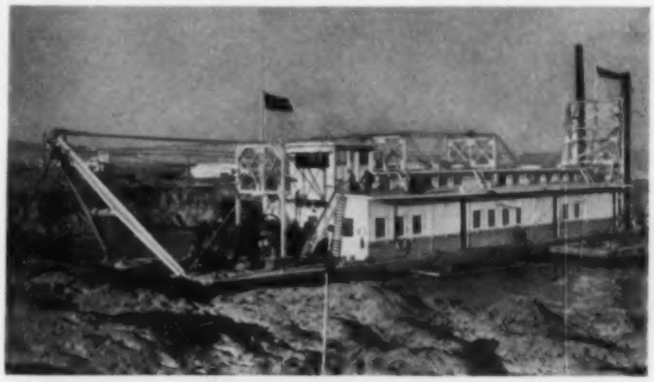
FOUR 14,000-HP DREDGES MAKE HYDRAULIC FILL

The embankment is unprecedented in size, being nearly five times larger than that for the Gatun Dam in Panama, at present the largest earth dam. The maximum vertical lift is over 200 ft, and the pipe line has a maximum length of over 17,000 ft. All these unusual problems complicated plant design and operation. The dredging is perhaps more interesting than any other phase of the work. This is being carried on directly by the government, on account of the peculiar construction hazards and the requirements for close control of materials and coordination of operations.

Each of the four identical dredge units consists of three parts—a dredge proper containing two 28-in. centrifugal pumps, direct-connected to 2,500-hp electric motors, set in tandem; a floating booster containing two pumps, also in tandem; a land booster operating on rails, with one pump. All pumps and motors are identical. Thus it is seen that each unit requires 12,500 hp for the pumps alone. The 700-hp cutter-head motor and auxiliary motors bring the total for each unit to approximately 14,000 hp. All pump motors operate at 6,600 v.

Cuts in the borrow pit average 225 ft in width. The cutter-head, on a 75-ft ladder, is normally held 45 ft below the water surface. Unusually high vacuums have been attained, often running as high as 24 in., without plugging the suction line. However, the average vacuum maintained is between 21 and 22 in. Pipe-line velocities are higher than usual, the average being approximately 21 ft per sec. The solids average about 15 per cent of the pumped volume.

Owing to the carefully designed ball joints and connections, the friction losses of head in the floating pipe lines have been somewhat lower than those normally expected. In the land lines, however, where 12-ft 6-in. sections of flanged steel pipe $^3/_4$ in. thick are laid with great care in long, straight reaches, the friction losses in head have been remarkably low.



DREDGE "A" FORMING A HARBOR FOR THE FLOATING PLANT IN THE LAY-UP SEASON

Ball-and-cone pipe lines, with turnbuckle-link connections, provide great flexibility in the discharge-pipe layout on the fill. When operations began it was necessary to build levees for each lift by means of draglines, but after reaching elevations above the crests of the gravel toes, the use of pocket pipe on trestles has materially reduced such levee construction. The beaches have an average slope of 2 per cent, are remarkably solid, and drain very rapidly. They resemble an ocean beach, smooth and firm, and heavy equipment such as tractors and trucks can move across the freshly deposited fill and even through the discharge water without trouble.

At the edges of the core pools, the solid sand beaches change gradually to the silt and clay core. The shores of the pools are never permitted to come within the designed core limits. To discharge the dredging effluent from the core pools, wooden cascade spillways are provided at the river ends of the cores. It should be explained that until the diversion tunnels are completed (probably in 1937) it is necessary to build up the fill on each side of the river, leaving an 800-ft opening for river flow. Plugs are provided at each spillway to hold the core material in place. These are built up by direct discharge from the dredge pipe lines, which insures that the material in the plugs will provide the required stability. To prevent undue seepage through the plugs, the steel sheet-pile cut-off wall is being extended up into the embankment at these points. The solids contained in the dredging effluent vary from 2 to 6 per cent.

One dredge unit, which was operated for $2^1/_2$ months in the fall of 1934, placed a total of 843,300 cu yd. All four units went into action in the spring of 1935, and on October 31, at the close of the season, 20,898,700 cu yd had been placed, making a total of 21,742,000 cu yd in position at the start of the present dredging season. This represents about 82 per cent of the material pumped into the dam. Designed to place a total of 3,000,000 cu yd per month, the dredges have exceeded this amount every month of the season. The best month was October, when 3,631,000 cu yd were deposited.

By careful planning, the loss of time due to pipe-line changes and replacement of worn parts has been reduced to a remarkably small amount. For the entire 1935 season, the average running time per dredge was slightly over 20 hr per day.

Work has been prosecuted at Fort Peck under weather conditions that were previously considered too severe for any construction operations. When the project was approved in the late fall of 1933, it was evident that the building of a branch railroad (over 12 miles in length) from the main line of the Great Northern Railway to the dam site was an immediate necessity if the work was to proceed without delay. Railroad construction during a Montana winter was thought by some to be impossible. Nevertheless, work was started on December 18, 1933, and proceeded with only brief delays until completion on April 15, 1934. Intense cold (as low as −35 F) in December and January, followed by an unseasonable thaw, failed to halt operations for more than a few days at a time. Power shovels and trucks built the grade.

PLACING HYDRAULIC FILL IN VICINITY OF UPSTREAM TOE, WEST SIDE, WITH 21-IN. POCKET PIPE

In the fall of 1934, construction of the diversion tunnels had advanced to a point where it was most important to place the concrete retaining wall at the outlet portals. With sub-zero weather approaching, plans were carefully worked out. Steam tunnels were located under the sand and aggregate storage piles, and heated enclosures were provided to cover the freshly poured structures. Concrete was placed when the temperature was −17 F.

Excavation for the spillway was begun in December 1934. Normally, operations would have been suspended during the winter months, but to do so in this case would have necessitated the layoff of many hundreds of men. Seasonal fluctuations of labor are highly undesirable on any construction job, and in sparsely settled Montana, where men must be brought long distances, financial loss and even real suffering would be the result of a layoff. Accordingly it was decided to continue work. Shovels, trucks, and tractors frequently were kept running continuously for days at a time to obviate the difficulties encountered in starting them at very low temperatures. The work proceeded throughout the winter season with only one shutdown, a period of eight days in January when the temperature was 25 deg or more below zero.

In such a brief paper it has been possible to mention only a few of the many interesting construction activities. There cannot be included the absorbing details of how the 288-mile power line was built in 120 days; how the steel sheet-piling cut-off wall was driven to depths consistently over 120 ft and to a maximum depth of 163 ft; how all previous world's records for tunneling were broken during the driving of the pilot bores of the diversion tunnels; and how, by careful planning, not less than 4,000 people have been employed continuously since June of 1934.

PRESENT STATUS OF THE WORK

On June 1, 1936, the status of the work was essentially as follows: On the dam itself, stripping and construction of the cut-off wall had been completed; 80 per cent of the gravel and rock had been placed in the toes; and over 27 per cent of the hydraulic fill had been placed. One dredge is now pumping into the dike section with a lift of over 200 ft. The other three dredges are continuing the placing of fill on the main parts of the dam on each side of the river.

OUTLET PORTALS OF DIVERSION TUNNELS, FORT PECK DAM

Work started on the diversion tunnels on May 24, 1934. The greater part of the excavation and concrete work at both inlet and outlet portals has been completed. The operations of enlarging and lining the tunnels and control shafts are proceeding steadily. Contracts for the caterpillar gates in the emergency shafts and the steel lining for the penstock portion of No. 1 tunnel have been awarded. Work is slightly ahead of schedule and no difficulty is foreseen to prevent completion of the tunnels in sufficient time to permit closure of the dam to be made in 1937. About 52 per cent of the tunnel work had been finished on June 1, 1936.

At the spillway, over 90 per cent of the 13,000,000 cu yd of excavation has been completed. Placing of the concrete lining is commencing and will probably be completed during 1936. An excellent start was made on the gate structure in 1935 and it is expected that this will be finished during 1937.

All phases of the work are up to schedule, and no obstacles can now be seen that will prevent completion of the project by 1939. The planning and design of all features of the project have been performed in the Missouri River division office of the Corps of Engineers at Kansas City, Mo., with Col. R. C. Moore, Corps of Engineers, as division engineer. Responsibility for the construction is placed on the Fort Peck District, of which the writer is district engineer.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Traveling Waves in Steep Channels

By W. H. Holmes, Assoc. M. Am. Soc. C.E.
Hydraulic Engineer, State Department of Public Works, Los Angeles, Calif.

From time to time reports have been heard of "walls of water" rushing out of steep canyons in semi-arid regions following intense local rainfall or cloudbursts, but authentic descriptions of these flows are rarely available.

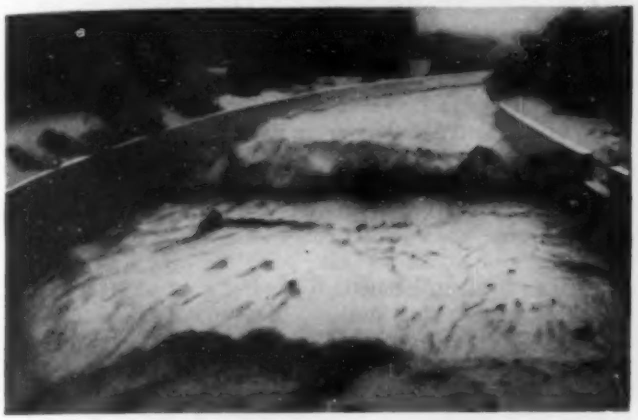


Fig. 1. A 5-Ft Wall of Water Moving Rapidly Down a Storm Channel

Several of These Wedge-Shaped Waves Were Observed; the Channel Between Them Was Almost Dry

Computations of the discharge made from the use of high-water marks, cross-sectional area, steepness of slope, and an assumed coefficient of roughness often indicate extremely high rates of discharge. For example, in one case four engineers, all of them members of the Society, made independent surveys of a flood from a drainage area of 30 sq miles and each computed the flow to be in excess of 2,000 cu ft per sec per sq mile. Yet the rainfall for the storm, as indicated by two gages near opposite ends of the area, amounted to about 1.50 in. One eye-witness described the flow as a series of high waves.

Perhaps a description of several of these waves that I have had an opportunity to observe will encourage further observation and discussion, which may lead to some method of predicting the occurrence and magnitude of such phenomena.

The channel on which my first observations were made was 43 ft wide, with vertical concrete side walls 8 ft high. The bottom had a slope of approximately 2 per cent, and was concrete-lined, but covered with sand and gravel about one foot deep. The lining of the walls extended for 800 ft upstream from the point of observation—a bridge—and for a mile or so downstream. Upstream from the lined section, the channel was confined to the 43-ft width by brush and wire fencing for a distance of 0.85 mile. There were several curves in the channel, but from the bridge 500 ft of channel was visible upstream and 800 ft downstream.

On December 14, 1934, a nearby recording rain gage indicated 0.6 in. of rain in 20 min. I anticipated a large flow following this rain, but on arriving at the bridge did not see any flow either upstream or downstream. I had started to leave when a traveling wave or wall of water, completely filling the channel and splashing over both side walls, passed by. The wave height did not change in the 1,300 ft of channel observed but continued to splash over the side walls. The wave passed and left the channel dry. A bystander later said that several waves had splashed over the side walls prior to my arrival.

Pictures were taken of the third and fourth waves observed. The crest of the one shown in Fig. 1 was about 5 ft high, yet when it was in the position shown, the flow at the white building, 400 ft upstream, was about half this depth. My general impression was that the waves were wedge-shaped, and that the length of the wedge was about half the distance between crests. Half of the channel length had no flow. After observing four waves I went upstream to locate the source, but did not succeed, and by the time I returned to the bridge the flow had ceased.

Another heavy rain occurred on January 5, 1935, from 2:00 to 3:00 a.m. The flow at 3:00 a.m. was uniform, and estimated to be 100 cu ft per second. By 3:40 the flow had doubled and short standing waves began to form. My flashlight did not give very good illumination but it appeared that these were the typical sand waves or scour waves that move downstream at a slow rate.

Rapidly moving waves began to form about 20 min later. The velocity of some of them was measured over a 400-ft course, and found to vary from 22.2 to 25 ft per sec, with an average of 23.5 ft per sec. The average frequency of the waves between 4:34 and 4:40 was 51 sec, with a minimum of 30 and a maximum of 63 sec. The largest wave was about 3 ft high.

If it can be assumed that the velocity and frequency of waves in the storm of December 14, 1934, were similar

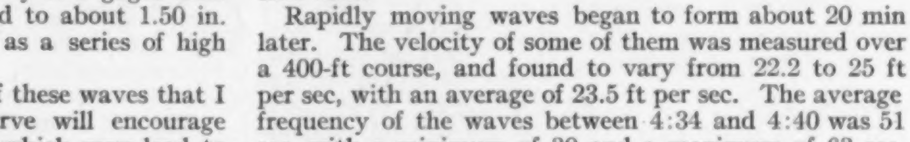


Fig. 2. Variation of Gage Height with Time in a Steep Flume

The Readings Were Taken at 1/16-Sec Intervals by a Moving-Picture Camera

to those of January 5, 1935, when the observed height of the highest wave was 3 ft, then the discharge for the storm of December 14, when the height of the wave was 8 ft, can be computed. The volume of water in one wave would have been $43 \times 8 \times \frac{600}{2}$, or 103,200 cu ft. But with a wave frequency of 51 sec, the average rate of flow would not have exceeded 2,000 cu ft per sec during the time that water was continuously flowing over the side walls.

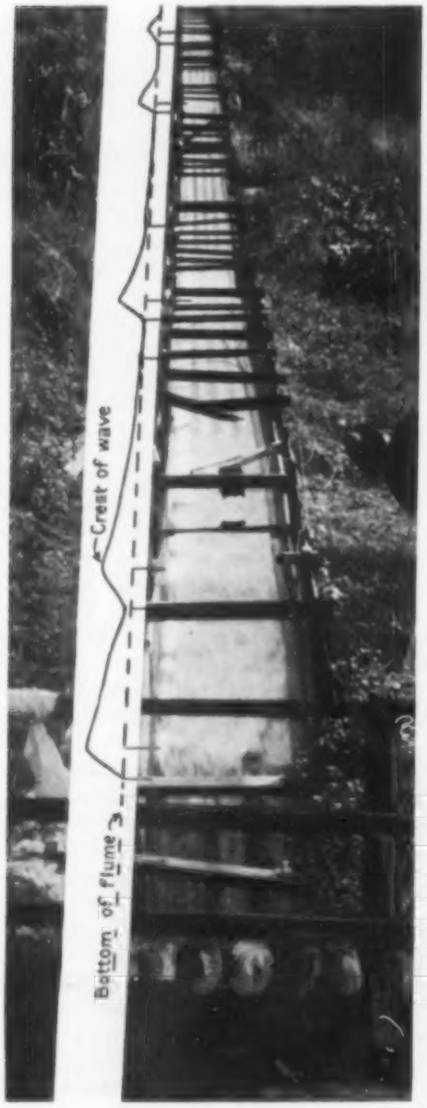


FIG. 3. FIVE WAVES IN A STEEP FLUME
The Longitudinal Battens Are Visible in the Wave Troughs

The capacity of this channel as computed by ordinary hydraulic formulas is seven to eight times the amount that filled it to overflowing.

It might appear from the foregoing observations that the Chezy formula could not in all cases be extrapolated for slopes of even 2 per cent. However, I have found it to check closely on one concrete-lined flume built on a 5 per cent slope (width, 4 ft; depth of flow, 5 in.; $c = 86$). No traveling waves developed in this flume.

On another occasion I examined a much steeper flume that for several years had produced traveling waves similar to those just described. This timber flume connects with a forebay at the head of a penstock and drops about 400 ft in a length of 700 ft. In its lower 400 ft, it is 30 in. wide; the sides are vertical; and the slope is 70 per cent. There are longitudinal battens on bottom and sides.

With a discharge of 4.5 cu ft per sec over the forebay weir into the flume, the flow in the flume occurred in traveling waves with an average frequency of 3.12 sec. The wave velocity was 35 ft per sec; and the maximum wave height was 6 in. Some waves were observed to overtake others and combine into larger ones moving at a higher velocity. This suggests that if the flume were longer the height and velocity of the waves might continue to increase; that is, the capacity of such a flume would vary as some inverse function of the length.

Motion pictures were taken of a staff gage in the flume, and individual frames of these pictures were read with a magnifying glass. In this manner a chart of staff-gage readings against time (Fig. 2) was prepared, showing the readings at $^1/_{16}$-sec intervals. By changing the time scale to a length, by multiplying time by velocity, a profile of the wave may be obtained.

Waves like No. 11 in Fig. 2 overtake No. 10 and combine to form waves of the size of No. 13 or No. 14.

A picture of the waves in this flume is shown in Fig. 3. The battens in the flume are clearly shown in the "dry" section between the waves.

The writer has been unable to find any mathematical analysis of this wave phenomenon. It has been suggested that the debris load may have contributed to the forming of the waves in the large channel, but in the small flume, with clear water, the waves appear to have been of the same type.

Formulas for Computing Mass Concrete for Morris Dam

By RALPH W. ALLIN, ASSOC. M. AM. SOC. C.E.
FORMER CHIEF FIELD OFFICE ENGINEER, MORRIS DAM, PASADENA WATER DEPARTMENT, PASADENA, CALIF.

TWO of the formulas used at Morris Dam for computing the volume of mass concrete below any given elevation are presented here, with the idea that they are general enough to be used for other dams. They afford a quick and accurate method of preparing monthly estimates.

Morris Dam, as described in the September 1935 issue of CIVIL ENGINEERING, is a concrete gravity dam partly straight and partly curved in plan. It was constructed in sections or blocks, the divisions between which are perpendicular or radial to the main axis. The formulas given here apply to the curved section only; those for the straight portion are similar but somewhat less involved.

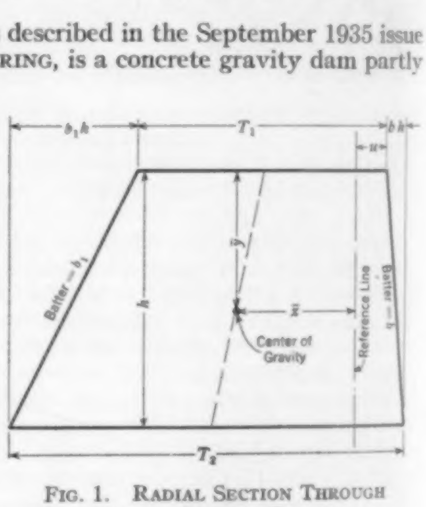


FIG. 1. RADIAL SECTION THROUGH LOWER PART OF BLOCK

The first formula is applicable below the beginning of the vertical curve on the downstream face. In addition to the nomenclature shown on Fig. 1, the following terms are required:

R = radius of curvature of the dam, measured to the reference line, in feet
L_R = nominal width of block (measured along arc through reference line), in feet
L_c = length of arc along center of gravity of a block, in feet
m = batter of the locus of the center of gravity as h varies
A = area shown in diagram, in square feet
V = volume in cubic yards

From the diagram, $T_2 = T_1 + bh + b_1h = T_1 + h(b_1 + b)$. The usual formula for locating the center of gravity is $\bar{y} = \dfrac{h}{3}\dfrac{(T_1 + 2T_2)}{(T_1 + T_2)}$.

Now, assuming $h = 1$,

$$m = \frac{T_2}{2} - \left(\frac{T_1}{2} + b\right) = \frac{1}{2}(b_1 - b).$$

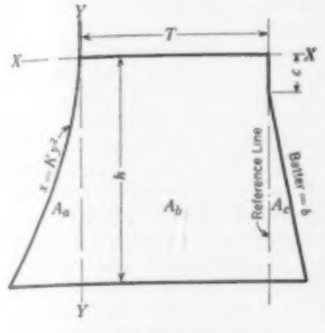


FIG. 2. RADIAL SECTION THROUGH UPPER PART OF BLOCK

Vertical Curve on Downstream Face

Also, $\bar{x} = \dfrac{T_1}{2} + m\bar{y} - U$.

Since arcs are proportional to their radii,

$$L_c = \frac{L_R(R - \bar{x})}{R}.$$

Finally, the volume of the solid generated by revolving any plane area about any non-intersecting line in its plane is

$$V = \frac{L_cA}{27}.$$

By combining the formulas the following is derived:

$$V = L_R\left[\frac{T_1}{27R}\left(R + U - \frac{T_1}{2}\right)h + \frac{1}{54R}\Big((R + U)(b_1 + b) - T_1b_1\Big)h^2 - \frac{1}{162R}\left(b_1^2 - b^2\right)h^3\right] \ldots\ldots\ldots [1]$$

A different formula is necessary for the upper part of the blocks, for there the downstream face is curved vertically. In Fig. 2 the radial section is divided into parts a, b, and c, and in the development of the formula corresponding subscripts are used to denote these parts; M_Y is the moment about the axis Y-Y.

$$A_a = \int_0^h Ky^2dy = \frac{K}{3}h^3;$$

$$M_{Ya} = \int_0^h\int_0^{Ky^2} xdxdy = \frac{K^2h^5}{10}; \quad \bar{x}_a = \frac{M_y}{A}.$$

$$A_b = Th;\ \bar{x}_b = \frac{T}{2}$$

$$A_c = \frac{b}{2}(h - c)^2;\ \bar{x}_c = \frac{b}{3}(h - c)$$

$$V = \frac{L_cA}{27};\ L_c = \frac{L_R}{R}(R \pm \bar{x}).$$

These equations combine to:

$$V = L_R\left[\frac{bc^2}{54}\left(1 - \frac{bc}{3R}\right) + \frac{1}{27}\left(T - bc + \frac{b^2c^2 - T^2}{2R}\right)h + \frac{b}{54}\left(1 - \frac{bc}{R}\right)h^2 + \frac{1}{81}\left(K - \frac{KT}{R} + \frac{b^2}{2R}\right)h^3 - \frac{K^2}{270R}h^5\right] \ldots [2]$$

This formula should not be used for values of h less than c.

Using convenient values of h, tables were prepared of the quantities within brackets in both formulas. The total quantity of concrete for each block above the elevation of the highest point of the foundation was then computed by multiplying the nominal width of the block by the quantity taken from the table for the proper value of h. The volume of concrete in any block at any time could then be determined, using the table in a similar manner, by computing the volume not yet completed and deducting it from the total.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Comments on Stabilizing a Bluff

DEAR SIR: In the May issue there is an article by Charles S. Whitney, M. Am. Soc. C.E., which deals with a sliding bank problem on Lake Michigan. In this article it is stated that a drainage tunnel cut at an elevation of about 50 ft above the lake in 1932, effected a cure. However, this assumption is at variance with the opinion of several persons, including the writer who did work for the owners concerned.

Tunneling would serve the purpose if the tunnel were run at a low enough elevation. But my subsequent operations on this property and other lakefront areas amply bear out the idea that, in such cases, effective drainage can be performed by deep cuts in the face of the slope. It is a matter of finding the low point of the water-bearing stratum and providing a proper outlet.

In May 1933, the year following tunnel construction, there was still some serious slumping at the crest of the bluff. In some places there were bad cracks, and large masses of ground had dropped several feet. At this time one of the two owners most affected considered improving his slope by dumping some 1,000 loads of soil on it. My advice was sought and was given to the effect that such a step would be disastrous.

Test holes showed that the property was saturated in the region immediately below the primary slope—that is, in the section just below the tunnel level. Most of the water was coming in from the west along the top of the hard clay layer. At the face of the bluff this meant an elevation some 12 ft below the tunnel. Continuing down the vein, the water entered a huge mass of sandy clay that had come down from previous slides and was still imprisoned by a dike of hard clay left by a slide many years before. In some places water was standing at the surface of the ground. With the existence of such a condition, continual slumps were inevitable.

Since the sandy clay mass was a slow conductor of water, it was not easy to provide satisfactory drainage. In the summer of 1933, I ran a drain from the shore west through the clay ridge, thence diagonally across the property to the north line. Although 26 ft deep in one place, this was accomplished by open cut with machine work. The cut was back-filled with several feet of coarse gravel on which were laid some 1,300 yd of sand from the beach, which had been built up by the so-called "experimental" groins that I had constructed in April 1932. Thus two purposes were served. At the north side there was laid another special type of drain which, at a point 80 ft west of the retaining wall, drained this area down to an elevation of about 13 ft above the lake, or a few feet below the lowest confines of the water-bearing sandy mass.

With the penetration of the clay ridge, the flow of water became heavy, amounting at times to 2,000 gal or more per day as water pockets were tapped. After the saturated mass of sandy clay was

drained the daily runoff from the two drains in 1933 was about 1,500 gal. As the sandy clay mass extended into adjacent areas at corresponding elevation, a slow drainage of these was also effected.

In Mr. Whitney's article it is stated that, after two years, there was a drop in the tunnel flow to 2,400 gal. Consideration of the foregoing will reveal some of the reasons for this although it must be remembered that in 1934 there was a serious decline in rainfall.

In May 1935, after a period of rainy weather, a last check made by the writer showed a flow of 3,600 gal per day from the two drains. As the property treated is 135 ft wide the flow per front foot would be at the rate of about 26 gal per day. On the occasion in question the tunnel was flowing at the rate of 5,500 gal per day. As this drains a frontage of about 530 ft the rate per front foot would be about $10^1/_3$ gal per day.

SYDNEY M. WOOD
Consulting Engineer

Lake Bluff, Ill.
May 26, 1936

Origin of Stadia Rod

TO THE EDITOR: I should like to make a slight correction to the "Engineers' Notebook" article on a stadia rod for long-distance survey work by G. J. Swartz, Jun. Am. Soc. C.E., which appears in the May issue of CIVIL ENGINEERING. Although I have used this type of rod on several projects for a number of years, I am not the originator. I first learned of it in 1926 from John C. Beebe, M. Am. Soc. C.E.

A correction should also be made in Fig. 1. For convenience in reading, the marking designated "10.0" should have been shown as a zero or some sort of an X.

DEMING W. MORRISON, Assoc. M. Am. Soc. C.E.

Alhambra, Calif.
May 27, 1936

Topographic Mapping of Basic Importance

TO THE EDITOR: In the course of discussion of the article, "No Maps in a Mapping Age," by William Bowie, M. Am. Soc. C.E., in the February issue, it has been stated that such questions as public education, international relations, or increasing taxation are more urgent for the preservation of the national welfare than maps. I believe that a study of any of these topics—education, international relations, or taxation—in its relationship to the national welfare would inextricably involve the other two topics and, eventually, the national topographic map.

It is self-evident that studies of national welfare cannot be separated from study of the land itself. Since our cities and towns, our public utilities and conveniences, our transportation system and resources—in short, everything material—have a connection with the land, a knowledge of the land is necessary for the proper planning, construction, and administration or maintenance of all public and private engineering projects.

Any attempt to show fully the relationship of education, international relations, and taxation to the national topographic map would require volumes, but it may be remarked that public education is supported by taxes, and that already a number of cities have found that a good map will produce an increase in tax revenues. Thus it may reasonably be expected that larger civil divisions, such as states and counties, will find good maps of like value. Although the national topographic map is not a tax map, the geodetic control which it requires as a base is desirable also as a base for accurate tax maps. Likewise state and county boundaries, in which tax collectors and school officials are interested, can be shown on a national topographic map.

As to international relations, will not an inventory of resources such as can be shown only on a good topographic map have considerable value in any particular study in this field? If an accurate study is to be made of international relations on any basis, is it not essential to know what and where our resources are and how they may be developed?

Does anyone believe that successful city planning can be accomplished without satisfactory maps? Planning is now generally accepted as indispensable to the improvement of living conditions—slum clearance, the development of parks and recreational areas, the improvement of transportation facilities. Can anyone believe that good maps are not essential to such undertakings? It is true that in the past major projects have sometimes been designed and built without benefit of good maps, and for this the people are paying in the form of additional first costs, added taxes, and increased maintenance costs. Not infrequently the bill is rendered in terms of human life, as when a dam which was designed and built without adequate basic data yields to an unusual flood.

We think of conservation as meaning the protection and economical development of our natural material resources, such as water, oil, and coal. But its most important form is the conservation of human life, and this rests on satisfactory maps. For a specific kind of conservation, consider the value of flood control. The past months saw one flood-control project—that at Dayton, Ohio—function satisfactorily. There were others of course that have a proved value. But the past months have also seen the lack of such flood-control projects responsible for a heavy toll of human life, great physical suffering, and the wholesale destruction of property. Would not adequate planning have prevented much of this loss and suffering, and are not good maps necessary for supplying the basic data essential in making such plans? Most assuredly this is so, and a base topographic map of the country would serve the fundamental purpose of supplying much of the required data.

HUGH C. MITCHELL
Senior Mathematician, Division of Geodesy, U. S. Coast and Geodetic Survey

Washington, D.C.
June 10, 1936

Multiple-Arch Dam in Australia

DEAR SIR: The accompanying recent photograph of the Belubula multiple-arch dam in Australia, sent me by R. F. Landreth has interested a number of engineers here, and I believe it may be of interest to the readers of CIVIL ENGINEERING. This is the second multiple-arch dam ever built, having been constructed in 1898. However, as the photograph shows, it is still in good condition.

BELUBULA MULTIPLE-ARCH DAM IN AUSTRALIA

According to a tabulation of dams, which appeared in the May 1928 issue of PROCEEDINGS, the maximum height of this structure is 60 ft, the total length 431 ft, and the buttress spacing 28 ft. There are seven arches. The lower part of both arches and buttresses is of unreinforced concrete, and the upper part is of brickwork. I am informed that the dam is still in use for diversion purposes, although its storage capacity is now nil.

ROBERT A. SUTHERLAND, Assoc. M. Am. Soc. C.E.

Hastings, Nebr.
May 27, 1936

Sixty-Sixth Annual Convention

Multnomah Hotel, Portland, Ore., July 15-18, 1936—Program of Sessions, Entertainment, and Trips

Opening Session and General Meeting

WEDNESDAY—July 15, 1936—MORNING

9:00 **Registration**

10:00 **Sixty-Sixth Annual Convention called to order by**

JAMES H. POLHEMUS, *M. Am. Soc. C.E., General Manager and Chief Engineer, The Port of Portland*, Portland, Ore; *President, Portland Section, Am. Soc. C.E.*

10:05 **Addresses of Welcome**

HIS EXCELLENCY CHARLES H. MARTIN, *Governor of the State of Oregon.*

HIS HONOR JOE K. CARSON, *Mayor of the City of Portland.*

10:15 **Response**

DANIEL W. MEAD, *President, American Society of Civil Engineers; Professor Emeritus, Hydraulic and Sanitary Engineering, University of Wisconsin; Consulting Engineer*, Madison, Wis.

10:20 **Annual Address**

DANIEL W. MEAD, *President, American Society of Civil Engineers.*

11:00 **The Oregon Country in History**

DR. HAROLD J. NOBLE, *Professor, History Department, University of Oregon*, Eugene, Ore.

12:00 **Business Meeting**

WEDNESDAY—July 15, 1936—AFTERNOON

SYMPOSIUM ON PROFESSIONAL ACTIVITIES OF THE SOCIETY

2:00 **Registration of Engineers**

JAMES L. FEREBEE, *M. Am. Soc. C.E., Chief Engineer, Milwaukee Sewerage Commission*, Milwaukee, Wis.; *Chairman, Committee on Registration of Engineers.*

2:15 **Engineering Salaries**

ERNEST P. GOODRICH, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.; *Chairman, Committee on Salaries.*

2:30 **Engineering Fees**

E. R. NEEDLES, *M. Am. Soc. C.E. Consulting Engineer*, New York, N.Y.; *Chairman, Committee on Fees.*

2:45 **Reemployment of Engineers**

GEORGE T. SEABURY, *Secretary, Am. Soc. C.E.*, New York, N.Y.

3:00 **Professional Development**

C. F. HIRSHFELD, *Esq., Chief Research Engineer, Detroit Edison Company*, Detroit, Mich.; *former chairman of Engineers' Council for Professional Development.*

3:15 **National Relations**

ALONZO J. HAMMOND, *Past-President, Am. Soc. C.E., Consulting Engineer*, Chicago, Ill.; *Society's representative on American Engineering Council and Construction League of the United States.*

3:30 **Education of the Public**

J. K. FINCH, *M. Am. Soc. C.E., Renwick Professor of Civil Engineering, and Director of the Summer School of Surveying, Columbia University*, New York, N.Y.; *Member, Committee on Public Education.*

3:45 **Aims and Activities of the Society**

J. P. H. PERRY, *M. Am. Soc. C.E., Vice-President, Turner Construction Company*, New York, N.Y.; *Chairman, Committee on Aims and Activities.*

4:00 **General Discussion**

WEDNESDAY—July 15, 1936—EVENING

7:00 **Dinner and Entertainment**

Ball Room, Multnomah Hotel.

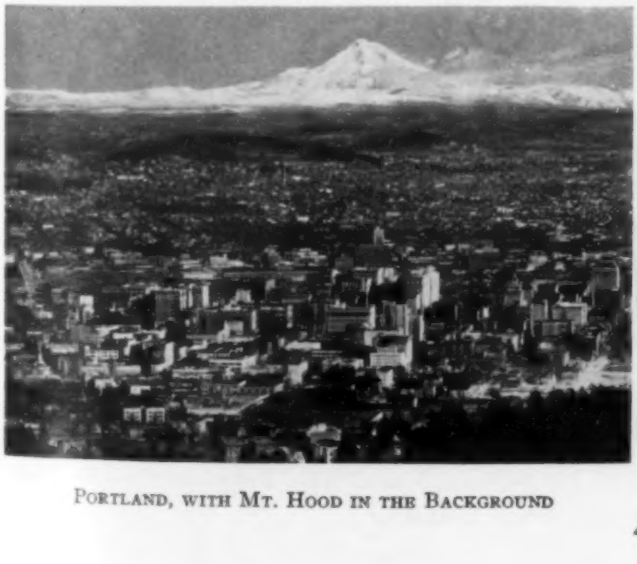
Toastmaster

J. C. STEVENS, *M. Am. Soc. C.E., Consulting Hydraulic Engineer*, Portland, Ore.

Speaker

FRANK BRANCH RILEY, *attorney and lecturer*, in his colorful travelog "The Lure of the Oregon Country."

Tickets for the dinner and entertainment are $2.00 each.



PORTLAND, WITH MT. HOOD IN THE BACKGROUND

THE PORTLAND WATERFRONT

PANORAMA OF THE BONNEVILLE PROJECT FROM WA[...]T, LOOKI[...]

One Day Devoted to Sessions [o]f Te[...]

THURSDAY—July 16, 1936

CONSTRUCTION, POWER, AND WATERWAYS DIVISIONS

MORNING AND AFTERNOON

9:00 **Construction Plant at Grand Coulee Dam**

C. D. RIDDLE, *Assoc. M. Am. Soc. C.E., Chief Engineer, Mason-Walsh-Atkinson-Kier Company,* Mason City, Wash.

9:30 **Discussion by**

FRANK A. BANKS, *Assoc. M. Am. Soc. C.E., Construction Engineer, U. S. Bureau of Reclamation,* Coulee Dam, Wash.

9:45 **Placing the Hydraulic Fill, Fort Peck Dam**

T. B. LARKIN, *M. Am. Soc. C.E., Lieutenant Colonel, Corps of Engineers, U.S.A.; District Engineer, Fort Peck Project,* Fort Peck, Mont.

10:15 **Discussion by**

CLARK KITTRELL, *Major, Corps of Engineers, U.S.A., Acting District Engineer, Fort Peck District,* Fort Peck, Mont.

T. A. MIDDLEBROOKS, *Assoc. M. Am. Soc. C.E., Associate Engineer, U. S. Engineer Corps,* Fort Peck, Mont.

11:00 **Improvement of the Columbia River for Navigation**

THOMAS M. ROBINS, *Colonel, Corps of Engineers, U.S.A.; Division Engineer, North Pacific Division, War Department,* Portland, Ore.

11:30 **Discussion by**

ROBERT E. HICKSON, *M. Am. Soc. C.E., Senior Engineer, U. S. Engineer Department,* Portland, Ore.

2:00 **Construction Features of the Bonneville Project**

C. I. GRIMM, *M. Am. Soc. C.E., Head Engineer, Office of Division Engineer, North Pacific Division,* Portland, Ore.

2:30 **Discussion by**

B. E. TORPEN, *M. Am. Soc. C.E., Senior Engineer, Corps of Engineers, U.S.A.; Bonneville Project,* Bonneville, Ore.

A. DONALDSON, *Assoc. M. Am. Soc. C.E., Office Engineer, Columbia Construction Company,* Bonneville, Ore.

3:00 **Hydraulic Models as an Aid in Design and Construction**

J. C. STEVENS, *M. Am. Soc. C.E., Consulting Engineer, Bonneville Hydraulic Laboratory, Stevens and Koon,* Portland, Ore.

3:30 **Discussion by**

JACOB E. WARNOCK, *Assoc. M. Am. Soc. C.E., Hydraulic Research Engineer, U. S. Bureau of Reclamation,* Denver, Colo.

GAIL A. HATHAWAY, *M. Am. Soc. C.E., Senior Engineer, U. S. Engineers, Missouri River Division,* Kansas City Mo.

4:00 **General Discussion**

HIGHWAY AND STRUCTURAL DIVISIONS

MORNING

9:30 **Design of Five Oregon Coast Highway Bridges**

O. A. CHASE, *Esq., Designing Engineer, Oregon State Highway Commission,* Salem, Ore.

10:00 **Discussion by**

RENE B. WRIGHT, *M. Am. Soc. C.E., Senior Highway Bridge Engineer, U. S. Bureau of Public Roads,* Portland, Ore.

10:10 **Construction Problems on Coast Highway Bridges**

G. S. PAXSON, *Assoc. M. Am. Soc. C.E., Acting Bridge Engineer, Oregon State Highway Commission,* Salem, Ore.

10:50 **Discussion by**

M. E. REED, *M. Am. Soc. C.E., Resident Engineer Inspector, PWA,* Newport, Ore.

11:00 **Highway Design, as Being Applied in the Oregon Highway System**

R. H. BALDOCK, *Esq., State Highway Engineer, Oregon State Highway Commission,* Salem, Ore.

11:35 **Discussion by**

LACEY V. MURROW, *Assoc. M. Am. Soc. C.E., Director of Highways, State Highway Department,* Olympia, Wash.

11:45 **General Discussion**

T, LOOKING NORTH, JANUARY 30, 1936

f Technical Divisions

IRRIGATION DIVISION

AFTERNOON

2:00 **Relation of Reclamation of Arid Land by Irrigation to the National Land Use Program**

J. W. HAW, *Esq., Director, Agricultural Development Department, Northern Pacific Railway Company*, St. Paul, Minn.

2:45 **Discussion by**

EDWARD HYATT, *M. Am. Soc. C.E., State Engineer*, Sacramento, Calif.

ROY F. BESSEY, *M. Am. Soc. C.E., Consultant, Pacific Northwest Regional Planning Commission*, Portland, Ore.

ROSS K. TIFFANY, *M. Am. Soc. C.E., Consulting Engineer*, Olympia, Wash.

3:00 **Lantern Slides Illustrating Features of Columbia Basin Project and Complete Irrigation Structures on Other Projects of the U. S. Bureau of Reclamation**

FRANK A. BANKS, *Assoc. M. Am. Soc. C.E., Construction Engineer, U. S. Bureau of Reclamation*, Coulee Dam, Wash.
Pictures used in illustrating this paper are shown by courtesy of Raymond F. Walter, M. Am. Soc. C.E., Chief Engineer, Bureau of Reclamation, Department of the Interior, Denver, Colo.

3:40 **Advantages of Irrigation in Western Oregon and Washington**

GEORGE E. GOODWIN, *M. Am. Soc. C.E., Senior Engineer, U. S. Engineer Department*, Eugene, Ore.

4:20 **Discussion by**

MILO P. FOX, *Lieutenant Colonel, Corps of Engineers, U.S.A., District Engineer, First Portland District*, Portland, Ore.

CHARLES E. STRICKLIN, *Esq., State Engineer*, Salem, Ore.

CHARLES J. BARTHOLET, *M. Am. Soc. C.E., State Supervisor of Hydraulics, Department of Conservation and Development*, Olympia, Wash.

M. R. LEWIS, *Esq., Professor of Agricultural Engineering, Oregon State College*, Corvallis, Ore.

SANITARY ENGINEERING DIVISION

AFTERNOON

2:00 **Sanitary Protection of the Portland, Ore., Water Supply**

B. S. MORROW, *Assoc. M. Am. Soc. C.E., Chief Engineer and General Manager, Water Bureau*, Portland, Ore.

2:40 **Discussion by**

W. A. KUNIGK, *M. Am. Soc. C.E., Superintendent, Water Division, Department of Public Utilities*, Tacoma, Wash.

3:00 **Control of Mosquitoes to Promote Comfort**

HAROLD F. GRAY, *M. Am. Soc. C.E., Sanitary and Hydraulic Engineer; Chief Engineer, Alameda County, California, Mosquito Abatement District*, Berkeley, Calif.

3:40 **Discussion by**

H. H. STAGE, *Esq., Associate Entomologist, U. S. Bureau of Entomology and Plant Quarantine*, Portland, Ore.

4:00 **Symposium on the Oregon Stream Cleansing Program**

(1) A Review of Past and Present Efforts to Reduce Stream Pollution in Oregon

RAY E. KOON, *M. Am. Soc. C.E., Chairman, Stream Purification Committee of State Planning Board; Consulting Engineer, Stevens and Koon*, Portland, Ore.

(2) The Status of Municipal Sewage Treatment and Disposal in Oregon

CARL E. GREEN, *Assoc. M. Am. Soc. C.E., State Sanitary Engineer, State Board of Health*, Portland, Ore.

(3) Industrial Waste Problems in Oregon

FRED MERRYFIELD, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, Oregon State College*, Corvallis, Ore.

GOLFING AT PORTLAND, ON THE WEST HILLS COURSE

Entertainment for the Ladies

WEDNESDAY—July 15, 1936—AFTERNOON AND EVENING

2:00 **Ladies Will Assemble at Multnomah Hotel.**

Cars will be in waiting to take them on a trip to the many attractive and scenic points of interest about the city. Tea will be served at the home of Mrs. James H. Polhemus. No charge.

7:00 **Ladies Will Join the Members for the Dinner and Travelog at the Multnomah Hotel.**

THURSDAY—July 16, 1936—MORNING AND AFTERNOON

8:00 **Trip to Mount Hood Loop**

Ladies will assemble at Multnomah Hotel. Cars will be in waiting to take them for an all-day trip up the Columbia River Highway and around Mount Hood, with a visit to Cloud Cap Inn. A box luncheon will be served at one of the Forest Camps enroute.

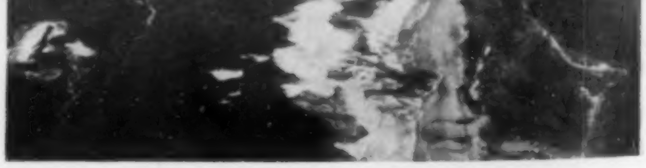
Tickets $1.00 each.

THURSDAY—July 16, 1936—EVENING

9:00 **Dance for Members, Ladies, and Guests**

Multnomah Hotel.
No charge, but registration is required.

MT. HOOD THROUGH A CLOUD BANK



ALONG THE OREGON COAST HIGHWAY

FISHING SCENE ON THE TRASK RIVER NEAR PORTLAND

All-Day Excursion to Bonneville on Friday

FRIDAY—July 17, 1936

8:00 **Excursion to Bonneville Development**

Assemble at Union Station for excursion by train in open coaches up the Columbia River to the Bonneville Navigation and Power Development (Federal Public Works Administration Project No. 28), being constructed by the U. S. Engineer Corps.

9:00 Stop enroute at Wahkeena Falls on the Columbia River Highway where the party will be the guests of the Portland Section of the American Society of Civil Engineers for an Oregon trout breakfast.

10:00 Continue the trip to Bonneville, arriving there at 10:30 a.m. The party will first assemble at the Bonneville auditorium for inspection of models of structures, followed by inspection of principal structures of Bonneville project.

Oregon's largest fish hatchery, adjacent to the government grounds, will be open for inspection by visitors.

The auditorium will be Bonneville headquarters, where spacious lounge and game rooms are available for card playing and other diversions.

A small golf course adjoins the auditorium.

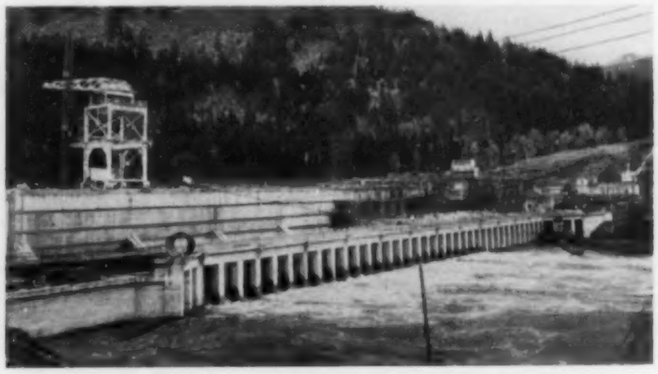
1:00 **Luncheon at mess hall of the Columbia Construction Company**

Those not wishing to inspect principal structures will obtain a bird's-eye view from points reached by motor coaches.

Return to Portland by motor coach, stopping at Multnomah Falls, Crown Point, and other scenic points along the Columbia River Highway, arriving at Multnomah Hotel about 5:00 p.m.

Tickets, including transportation and luncheon at Bonneville, $2.50 each.

PARTLY COMPLETED SPILLWAY DAM, BONNEVILLE



TAILRACE OF THE BONNEVILLE POWER HOUSE

Saturday Trips

SATURDAY—July 18, 1936

Members have the choice of four trips as follows:

Grand Coulee Dam

Those taking this trip will board trains at the Union Station in Portland on Friday evening for Spokane, Wash., as follows:

RAILROAD	LEAVE PORTLAND	ARRIVE SPOKANE
Union Pacific	9:30 p.m. Friday	7:00 a.m. Saturday
Spokane, Portland and Seattle Railway. . .	9:30 p.m. Friday	7:00 a.m. Saturday

Upon arrival in Spokane, the party will be met by members of the Spokane Section of the Society and taken to the Davenport Hotel for breakfast. Immediately thereafter the party will go by automobile or motor coach to the Grand Coulee Irrigation and Power Development (Public Works Administration Project No. 1242) being constructed by the U. S. Bureau of Reclamation. Luncheon will be served at the mess hall of MWAK Construction Company, Mason City, Washington. The party will return to Spokane about 7:00 p.m. in time to board eastbound trains.

Tickets for transportation from Spokane to Grand Coulee and return, including breakfast at the Davenport Hotel and luncheon at the dam, are $5.00 each.

Stop-overs at Spokane are allowed on through railroad tickets.

Portland's Water Supply System—Forenoon

This trip will include a visit to the Bull Run Dam and storage reservoir 30 miles distant, where the city takes its domestic water supply from Bull Run River, a clear mountain stream heading in copious springs on the slopes of Mt. Hood. On the return trip, the several storage reservoirs within the city will be visited.

The party will start from the Multnomah Hotel at 8:30 a.m. and return at 1:00 p.m. in order that those so desiring may join the party on the trip to the Ariel Power Plant.

No charge will be made but members wishing to take the trip are urged to register as early as possible in order that adequate transportation facilities may be arranged for.

Bonneville Hydraulic Laboratory—Forenoon

Cars will be in readiness at 9:30 a.m. to take the party to the laboratory at Government Moorings within the city, where the models of the Bonneville Dam and 5 miles of Columbia River will be in operation.

No charge.

Ariel Dam and Power Plant—Afternoon

Those wishing to visit a modern power development will be the guests of the Northwestern Electric Company, which will furnish transportation for a trip to their latest development on Lewis River near Woodland, Wash.

The party will start from the Multnomah Hotel at 1:30 p.m. and return about 5:30 p.m.

No charge will be made but members wishing to take the trip are urged to register as early as possible in order that adequate transportation facilities may be arranged for.

Hotel Accommodations and Announcements

Hotel Rates

Hotel	With Bath		Without Bath	
	Single	Double	Single	Double
Multnomah	$2.50 up	$3.50 up	......	......
Benson	2.75 up	3.75 up	......	......
Portland	2.00 up	3.00 up	$1.50 up	$2.00 up
Heathman Hotels	2.25 up	3.25 up	1.75 up	2.50 up

Members are urged to make definite arrangements at least a week in advance of the Annual Convention.

There will be no increase in the regular rates at any of the hotels during the Convention.

The Multnomah Hotel is the Society Headquarters for the Convention.

All who attend the Annual Convention are requested to register immediately upon arrival at Meeting Headquarters. Special badges and tickets will be obtained at the time of registration.

Information

A registration desk will be provided in the Headquarters hotel to assist visiting members in securing any desired information about the city. At the registration desk, a card file of those in attendance will be maintained, with information as to members' Portland addresses.

Local Section Conference

On Tuesday afternoon, July 12, 1936, there will be a conference of delegates from the 12 Local Sections in the Western Meeting Region with the Society's Committee on Local Sections and the Western Region Meetings Committee.

A comprehensive agenda has been prepared for the discussion of activities of mutual interest to the Local Sections.

All interested members are invited to attend and participate in the conference.

Entertainment

Attention is directed to the program for the entertainment of the ladies. The ladies are cordially invited to participate in all the other features of the meeting that may interest them.

Facilities will be accorded to members wishing to play golf. Make application at the registration desk.

Order All Tickets in Advance

Members who order tickets in advance will not only be saved annoyance and delay by having tickets and badges awaiting them on arrival at Headquarters, but they will assist the committee greatly by giving advance information to guide it in concluding arrangements.

See page 16 in back of this issue for registration and ticket order forms.

Make reservations directly with the hotel or through the local committee as early as possible and thus avoid inconveniences and delays. Any requests addressed to J. C. Stevens, M. Am. Soc. C.E., General Chairman, Spalding Building, Portland, Ore., will be promptly attended to.

Highways, Railroads, Steamships

The Oregon country is covered by a network of paved highways. Railroads radiate in all directions, and transportation by water is everywhere available. Requests for information made to the Travel Bureau, Multnomah Hotel, Portland, Ore., or to the Local Committee on Arrangements will be promptly supplied.

Invitation to Student Members

Members of Student Chapters are invited to attend and participate in all the events of the Annual Convention.

What to Wear

If Oregon runs true to form the days will be warm and sunny and the nights comfortably cool. Summer clothing will be in order. If you want to know the average weather statistics, write for them but don't expect the average—it's always "unusual."

Local Committee on Arrangements

J. C. STEVENS, *General Chairman*

Finance Committee: E. B. MACNAUGHTON, *Chairman;* G. HASELTON, G. KIMBRELL, C. A. MOCKMORE, S. MURRAY.

Publicity Committee: O. E. STANLEY, *Chairman;* P. H. BLISS, A. J. GILARDI, K. L. KOLTRIN, F. R. SCHANCK, C. F. THOMAS.

Registration Committee: B. S. MORROW, *Chairman;* T. R. CANTINE, J. W. DOUGHERTY, F. T. FOWLER, L. F. HENSHAW, N. H. LEUPOLD, H. A. RANDS, H. B. STANLEY, E. C. WILLARD.

Excursion Committee: C. I. GRIMM, *Chairman;* ALBERT BAUER, H. E. BROWN, A. L. HENNY, R. E. HICKSON, B. M. HOWARD, F. KOCHIS, W. W. LAXTON, R. E. MACKENZIE, F. H. MARSH, H. McC. MASON, K. N. PHILLIPS, B. E. TORPEN.

Program Committee: J. W. CUNNINGHAM, *Chairman;* C. E. GREEN, P. L. HESLOP, R. E. KOON, F. MERRYFIELD.

Decorations Committee: C. P. KEYSER, *Chairman;* MRS. G. W. BUCK, R. R. CLARK, MRS. R. R. CLARK, MRS. R. E. KOON, MRS. S. MURRAY, MRS. E. R. WALSH.

Recreation Committee: J. H. POLHEMUS, *Chairman;* L. GRISWOLD, R. B. HAMMOND, C. J. MCGONIGLE, F. P. OBEE.

Ladies' Entertainment Committee

MRS. L. GRISWOLD, *Chairman*

MRS. T. R. CANTINE	MRS. B. S. MORROW
MRS. J. W. CUNNINGHAM	MRS. F. P. OBEE
MRS. T. M. DAVIS	MRS. J. H. POLHEMUS
MRS. C. I. GRIMM	MRS. M. E. REED
MRS. B. M. HOWARD	MRS. O. E. STANLEY
MRS. C. P. KEYSER	MRS. J. C. STEVENS
MRS. FRANK KOCHIS	MRS. C. F. SWIGERT
MRS. GEORGE C. MASON	MRS. E. C. WILLARD

The program as a whole has been prepared under the direction of the Committee on Regional Meetings, composed of HARRY W. DENNIS, *Vice-President, Am. Soc. C.E., Chairman;* and IVAN C. CRAWFORD, B. A. ETCHEVERRY, R. A. HILL and T. A. LEISEN, *Directors, Am. Soc. C.E.*

Please call on the Local Committee on Arrangements or on the Secretary's office for any service desired.

Summer Excursion Rates Will Be in Effect to Portland from the East. Consult Your Local Ticket Agent.

SOCIETY AFFAIRS

Official and Semi-Official

Preparations Completed for Sixty-Sixth Annual Convention

Attractive Program Arranged for July 15 to 18 at Portland, Ore.

At the Annual Convention in Portland many subjects of special interest in connection with the engineering development of the Northwest will be presented. Among these may be mentioned papers on and visits to the gigantic Fort Peck Dam on the Missouri River, the Bonneville Dam on the Columbia River, and the Grand Coulee Dam, also on the Columbia.

Details of the various sessions have now been perfected, and the official program appears in this issue. Preparations have been going forward for months to care for the needs of every visitor. A valuable as well as an enjoyable group of papers and addresses will be delivered. Railroad fares are low.

A special Convention tour will leave Chicago on July 5, arriving at Fort Peck July 7. After a day's inspection of the dam, the train will proceed to Glacier National Park. Visits by motor to nearby points of scenic interest will be made on July 9 and 10, and on the eleventh the group will motor to Grand Coulee Dam. The train will continue to Portland that night, arriving on the morning of July 12. A choice of four other inspection trips may be made, as listed in the program elsewhere in this issue.

On the whole it is difficult to see how a more instructive and enjoyable program could have been arranged. Sixteen timely papers are scheduled for presentation, under the auspices of the Construction, Power, Irrigation, Highway, Structural, and Sanitary Engineering Divisions. A symposium on the professional activities of the Society is also scheduled. Local members are known to be planning to support the Convention in large numbers, and many others even from a considerable distance also plan to be present.

For the benefit of those who may be unable to attend on account of distance or for other reasons, as much of the technical material as can be included within the pages of Civil Engineering will be made available. According to present plans abstracts of the various papers and reports will appear in the October number.

Local Sections Conference to Be Held at Portland

The next conference of representatives from Local Sections will be held at Portland, Ore., on Tuesday, July 14, 1936, at the time of the Annual Convention. The representatives will come from the Sections in the Western or Annual Convention Region.

Sections eligible to send an accredited representative, whose traveling expenses will be paid in part by the Society, are as follows:

Arizona	San Diego
Colorado	San Francisco
Los Angeles	Seattle
New Mexico	Spokane
Portland, Ore.	Tacoma
Sacramento	Utah

As is the custom at such conferences, a definite part of the proceedings will be devoted to a consideration of when and where the Annual Convention of the Society for 1937 shall be held in that region. The principal topics for discussion at that Convention will also be considered. The resulting recommendations go to the Western Regional Meetings Committee of the Board of Direction, which is charged with the final decision and takes the initial steps in putting the plans into effect.

In addition, there will be provision for the discussion of topics of interest to all the Local Sections.

Juniors Supply Local News for Civil Engineering

Within the past few weeks 16 juniors in various parts of the country have been designated as "Junior Correspondents for Civil Engineering." Similar appointments will continue to be made until each Local Section interested in the project has at least one such representative. The plan, when in full operation, will provide an opportunity for fifty or more Juniors to participate actively in Society work.

The primary function of the new correspondents is to develop brief items of special interest to members in the particular localities they represent—items that might otherwise escape the attention of the editorial staff. In Local Sections that at present do not have publicity committees, they may also assist the secretaries in preparing detailed accounts of local Society activities.

Appointments are made by the Secretary of the Society on the basis of recommendations from Local Section officers. Up to June 12, the following Juniors had been assigned:

Local Section	Junior Correspondent
Buffalo	Guy Moore, Jr.
Central Ohio	P. W. Holstein, Jr.
Colorado	R. E. Van Liew
Georgia	Thomas Jackson Durrett, Jr.
Indiana	K. B. Wolfskill
Iowa	O. J. Baldwin
Kentucky	H. St. G. T. Carmichael, Jr.
Los Angeles	John M. Server, Jr.
Metropolitan	Alfred Africano
Milwaukee	Ira N. Curtis
North Carolina	A. R. Hollett Walter J. Parks, Jr.
Northwestern	J. F. Ripken
Panama	Malcom S. Stevens
Portland (Ore.)	P. H. Bliss
Sacramento	Arthur H. Castelazo

It is anticipated that the correspondents can help to enliven the "Items of Interest" section with stories of interesting personal experiences written up from interviews with members in their vicinity, accounts of early-day engineering achievements of historical interest, and similar items. For the "News of Engineers" section, the staff has been dependent in the past largely on notices of changes in address and other information received more or less at random. The junior correspondents will be expected to keep closely enough in touch with all members in their vicinity to make sure that changes of employment and awards of significant honors are promptly and fully reported. They will also be on the lookout for "Engineers' Notebook" material.

A number of contributions by junior correspondents have already been published. A large part of these efforts obviously must remain anonymous, as it is impracticable to give specific credit except for the longer items that are suitable for distinctive or feature treatment.

More Flood Pictures Desired

In response to a request in the June issue a number of photographs of recent floods and their effects have been received. Others will be welcome. They should deal not with the horrors or tragedies, important as they may be, but rather with the engineering aspects of the floods, to show the conflict between the forces of nature and the works of man and the mutual reactions of each on the other. This second notice, it is hoped, will secure a generous quantity of photographs to be used in connection with discussion of floods at the Pittsburgh Meeting of the Society in October.

Increasing the Scope of the Local Sections

Problem of Assigning All Society Members to Local Groups Discussed at Hot Springs Conference

DISCUSSION at the recent Southern Region Local Sections Conference at Hot Springs, Ark., centered about the question of assigning every member of the Society to some Local Section. The Conference voted unanimously to request the Committee on Local Sections and the Society staff to prepare a definite proposition on the subject for presentation at the Fall Meeting at Pittsburgh. In accordance with this request, a plan is now being developed; the problem also will be discussed at the Annual Convention in July.

In outlining the discussion, Vice-President Donald H. Sawyer, M. Am. Soc. C.E., who presided, pointed out that the idea of an immediate universal allotment of members to Local Sections has not met with unanimous approval. "I think it would be unfortunate to take this step," he said, "until we take into account all the difficulties it might raise. The Board of Direction wants to take a good look at all the possibilities. It would be simple enough to assign members to some Section, so far as we have Sections, but the minute you begin to allot money to the Sections on the basis of the new membership you are getting into sizable sums. Will that money be spent for helpful purposes? Will we better present conditions?"

The importance of assigning all members to Local Sections was stressed by E. B. Black, M. Am. Soc. C.E., a member of the Committee on Local Sections. "Our committee," he said, "has been trying to work out some comprehensive plan to bring the Society, the Local Sections, and the members closer together. The program we had worked out—an outline containing general suggestions—was presented to the Board last January and sent back for further consideration.

"The Committee feels that one of the best ways to make these contacts what they should be is to assign every member to a Section, so that once having paid his dues to the Society he shall consider himself without reservation or embarrassment a member of a Local Section—whether this means the payment of local dues so small that every member can afford them, or an allotment from the Society itself. We are not trying to interfere with any activities the Local Section may wish to carry on in addition to those things that should properly be financed by allotment. The Committee believes that the only way the national organization can prosper, extend its influence, and do the most for the profession, is by having the largest possible proportion of its membership in these local groups."

On motion, Mr. Black's remarks were endorsed unanimously by the Conference. John C. Hoyt, M. Am. Soc. C.E., of the District of Columbia Section, pointed out that every member of the Society in that area receives a notice and invitation to every meeting, and is already a member of the Section, so far as participation is concerned, regardless of whether he has paid the $1.00 dues of the Section. "If the Society would allot a nominal amount to cover the overhead for mailing," said Mr. Hoyt, "I believe we could accomplish just what the Committee wants us to do. Let each Section decide whether it wants to spend more money than that and raise it by subscription."

W. H. Meier, M. Am. Soc. C.E., president of the Texas Section, commented that the Texas Section also invites all Society members resident in the state to attend its meetings, and sends them the Section year book and monthly periodical as well. About a third pay dues to the Section, he said. The Georgia representative, L. F. Bellinger, M. Am. Soc. C.E., reported a similar arrangement. He suggested eliminating local dues, except perhaps a nominal amount for those living in the "headquarters city"—Atlanta.

"With increased allotments," said Mr. Bellinger, "Local Sections could secure the loan of technical films, pay part of the expenses of speakers from outside the city, and establish local prizes. I think the allotments should not go for payment for food."

By letter, P. A. Rice, Assoc. M. Am. Soc. C.E., secretary and representative of the Virginia Section suggested that if the present income from local dues should be replaced by allotment it should be not less than $2.00 nor more than $3.00 per member. He recommended using the increased income for publicizing engineers and engineering projects in local papers, conducting more active work in the engineering schools, building up a reserve to finance a Spring Meeting of the Society, conducting a more active drive for a revised registration law, and improving and enlarging the Section year book. The Virginia Section has always sent notices of all its meetings to every member of the Society resident in the state.

In This Issue . . .

Also on the agenda of the Conference was a discussion of a check list of desirable procedure for Local Sections. A pamphlet on the subject was proposed at the Birmingham Conference in September 1935, and at that time it was suggested that the various Sections should have an opportunity to recommend specific items that should be included in the draft. Mr. Hoyt opened the discussion with the observation that Local Section meetings should emphasize social activities and discussion of Society affairs.

"In Washington there are altogether too many technical meetings sponsored by all sorts of organizations," he said. "We can attract only 20 or 25 men to a technical meeting, but we can turn out 100 or more to discuss Society affairs or some general subject—or just to get acquainted. I hope the restrictions on types of meeting, so far as they affect allotments, may be liberalized." The Committee on Local Sections had previously recommended to the Board such a liberalization; the Board approved the recommendation at Hot Springs and Section officers have been notified. A statement of the new definition of a technical meeting appeared on page 392 of the June 1936 issue of CIVIL ENGINEERING.

Another member observed that the rulings on what constituted technical meetings had been quite liberal, and Field Secretary Jessup stated that questions about allotments had arisen largely from the failure of the Sections to report their meetings in accordance with the requirements, rather than from the nature of the meetings.

Mr. Meier recommended that each Local Section consider the advisability of publishing a monthly journal to be circulated not only among Society members but among all engineers in its area. "In our journal, *The Texas Engineer*, there are notes of what is happening to engineers, personal notes, information about work that is under way, and one technical paper. During the past year the journal has been a little more than self-supporting because we sold advertising space."

Mr. Bellinger asked that all Sections record their experiences—and particularly their failures—with a varied list of items including luncheons, clubrooms, hired publicity managers, use of Juniors on committees, number of meetings, date and hour of meeting, and manner of notification.

The Conference also gave attention to the relations between Local Sections and Student Chapters, to the plan for appointing junior correspondents for CIVIL ENGINEERING, discussed elsewhere in this issue, and to informal reports of local engineering em-

SIXTY-SIXTH ANNUAL CONVENTION, July 15–18, 1936, in Portland, Ore.

ployment conditions. Salary trends were reported as stationary or upward. In the vicinity of the Sections represented, practically all members of the Society are at present employed. One Section reported that private organizations in its territory are having a hard time to find men.

Resolutions endorsing the action of the Board in calling the Section Conferences and in sending the Field Secretary on his trips to Local Sections were unanimously adopted.

[A comprehensive abstract of the Conference proceedings has been prepared at Headquarters for distribution to the officers of all Local Sections.]

What Is a Fellow?

Once boasting a goodly percentage of Society members, the grade of "Fellow" has now been reduced to a single incumbent. The purpose or origin of this class of members is of interest, as well as the reasons for its decline. The history of the matter goes back as far as June 1868, at which time the Society decided that a fund be raised by "fellowship among the patrons and capitalists of public improvement and those interested in the onward progress of the sciences." As given in the Society Constitution printed in 1870, it was provided that "There shall be a fund, called the 'Fellowship Fund,' devoted exclusively to the publication of the papers read before this Society. Any persons, whether members or otherwise, if acceptable to the Society may subscribe thereto. The subscribers to this fund shall be called 'Fellows of the Society.'" It was further provided that such Fellows should receive the Society's publications but would not be permitted to vote. The actual inauguration of the plan, however, seems to have been delayed, for there is no record of election to this grade until 1870. Furthermore, the matter was the source of extensive discussion during 1875, as indicated in the report of that year's Convention.

At that time the question of proper qualifications for persons to be so admitted was at issue, and various interpretations were placed upon the possible wide extension of the new class of membership. On this point, William P. Shinn, later President of the Society, observed, "They are persons who unite with the association to obtain for themselves its advantages and benefits, and the amount of contribution which constitutes them Fellows is not of more value than they are likely to receive in return." At this meeting, the late Alfred P. Boller, M. Am. Soc. C.E., also an early officer of the Society, believed in a liberal interpretation. He stated that "Taking in view the object of Fellowship, as expressed in the Constitution, I do not see that we can require any other record of Fellows, than to show they are honorable men. Their motives, or the nature of their business, cannot be inquired into."

Interest Only to Be Used

Only the proceeds from the investment and not the principal were to be used. In their more enthusiastic moments the originators, of whom Mr. Boller seems to have been the leader, expected to set up a total of $20,000, but actually the fund only reached about half that amount. Even so the income of a few hundred dollars annually seemed quite appreciable. It helped to print the technical papers from the semi-monthly meetings and distribute them to the then limited membership. But as the scope of Society work grew the insufficiency of this means of financing publications became apparent and so the enthusiasm seems to have waned.

Other factors also may have entered in. For instance an interesting old Society record, comprising a handwritten "list of members" indicates that 43 Fellows were admitted during the first year, 1870, upon payment of $100 each. Evidently this led to a false confidence, for the Fellowship fee was increased to $250 in 1872–1873. Curiously, elections ceased. The fee was reduced to $150 in 1874 but no new Fellows entered until 1876. By the Constitution adopted in March 1891, the Fellowship fee was again put back to $250.

There may have been other factors at work, but judging simply from these records it does seem that the amount of the fee and the number of admissions to Fellow were distinctly related. This evidently was in the mind of Charles McMillan, of Rensselaer Polytechnic Institute (who later served for many years as professor of civil engineering at Princeton). In April 1869 he wrote:

"I have very recently received a circular regarding the establishment of a Publication Fund, and must say that I regret that the fixed amount of the subscription will necessarily keep my name from the roll of the Fellows of the American Society of Civil Engineers, at least, until I can secure the requisite amount of spare cash, or until, possibly, the amount of subscription is either lowered, or in some way graduated so as to enable those of slender means to secure the privilege of a restricted membership—as 'Little Fellows' for instance."

An Imposing Roster

In looking over the list of early Fellows one is impressed with the fact that much personal effort must have been given by interested members. R. N. Brown proposed eight; and H. M. Gardner and E. S. Chesbrough, later President, five each. Another subsequent President, Charles Hermany, was responsible for seven Fellows, all in one year, 1872, and all from Louisville, Ky. A small proportion seem to have been engineers but the remaining names on the list were probably men of means—financiers, philanthropists, contractors, and others who were proud to be in such good company and to contribute financially toward technical progress.

In the first years' list were names to conjure by: John B. Jervis, later an Honorary Member; George H. Norman, for whom the Norman Medal was named; James B. Eads, then registered from St. Louis; and James B. Francis, whose address in Lowell, Mass., is hardly needed. In a few years came Thomas C. Clarke, Octave Chanute, and Albert Fink, all later Presidents, and Theodore G. Ellis, soon to be honored as Vice-President of the Society. Surely the grade of Fellow was most honorable.

In the first enthusiasm the list of Fellows quickly reached 50 and for 15 years it hovered between 55 and 60. The maximum, 62, was recorded for the year 1873. In all, nearly 100 were elected to the grade, the last being in 1899. From 1886, when there were 57 Fellows, the number decreased slowly but continuously. At the turn of the century there were 37; in 1920, only 10; and at the beginning of 1936, two still remained.

Fellowship Fund Loses Identity

In the Proceedings for 1875, reporting that year's Society Convention, it was recorded:

"The establishment of the 'Fellowship Fund' must be referred to as a happy conception, and successful in its results. . . . Not only is this fund the means of augmenting the wealth of the Society, but it also brings together the agents of modern civilization—the engineer, the constructor, and the capitalist."

The fund well served its day and generation. It was kept intact until June 1933 at which time it amounted to about $13,000. Then in order to simplify financial procedures, and to bring Society funds more in accord with current conditions, the Board of Direction, with the advice of counsel, took the following action:

"Resolved: That the Fund created by fellowship dues now carried on the books of account of the Society as a separate fund and investment under the title 'Fellowship Fund' be discontinued, and that the securities and other assets allocated to said Fund be transferred on the books of account of the Society to its General Assets."

Columbia University Scholarship Available

Applications for the Columbia University Scholarship, beginning with the year 1936–1937, should be filed without delay. This scholarship, which is awarded by the Scholarship Committee of the Society to a candidate whose records have been approved by the Columbia University authorities, has been established in honor of Horatio Allen, a noted graduate of the university and fifth President of the Society.

The scholarship should appeal particularly to the outstanding student who has completed two years or more of undergraduate work and who may wish to attend a large institution amid metropolitan surroundings, but it is available to the successful candidate for from one to three years, depending on the class which he enters. The money value of the scholarship is estimated as at least $400 per annum. All necessary details will be gladly supplied on request to Headquarters.

Early Presidents of the Society

This is the fourth of a series of brief biographies of the men who guided the Society through its formative years. The next three issues will contain stories of Horatio Allen, Julius Walker Adams, and George Sears Greene. Perhaps there are readers who have access to little known facts or personal anecdotes about these engineers. If so, they are urged to take a part in making these records interesting and complete by communicating with Society Headquarters.

IV. Alfred Wingate Craven, 1810–1879
President of the Society, 1869–1871

In the early 1830's Alfred Wingate Craven, as a young graduate of Columbia College, took up the study of law, was admitted to the bar, and hung out his shingle in New York City. His career as a lawyer, however, was brief; he soon found that the profession he had chosen "was not congenial to his tastes." Craven was a man of fine physique, and apparently an accomplished athlete. The outdoor life of the civil engineer appealed to him, and at 25 he set about to learn his second profession.

Alfred Wingate Craven
Fourth President of the Society

The first American school of civil engineering—as someone has called the canals of the seaboard states—was beginning to lose its pupils to another practical institution of learning, the railroad, that in the next few decades produced many a famous engineer. Craven took up his study in the younger school, and soon worked his way into the front rank of its pupils. After seven years on railroads in Ohio, South Carolina, Massachusetts, and New York, he was made chief engineer of the Mohawk and Hudson.

Apparently he had learned more than the technical aspects of engineering, for it is recorded that he left this position because of his refusal "to assent to management which he considered inconsistent with professional honor." Shortly thereafter he became chief engineer of the Schuylkill Valley Railroad and the Mine Hill Navigation and Railroad Company.

In 1849 the Croton Aqueduct Department was created by act of the New York State Legislature. The new organization was to have charge of all the water works of the City of New York, and of constructing and maintaining the sewers and drains. One of the three commissioners was to be a civil engineer, and Craven was selected for the post.

In those days, when engineers were even more nomadic than today, Craven's 19 years of continuous service with the Croton Aqueduct Department must have set something of a record. And the tenure seems all the more remarkable in view of the political nature of his appointment, and the fact that during most of the period his affiliations were with the minority party. It suggests, and the record bears out, that he was a man of marked ability and uncompromising honesty.

Those who have read Clemens Herschel's *Frontinus and the Water Supply of the City of Rome* will be struck with a number of parallels between the municipal career of Craven and that of the Roman water commissioner. Both men came into office charged not so much with construction as with the maintenance of an existing system. And the water supply of New York, like that of the Rome of 1,800 years before, came to the city from faraway hills by way of masonry conduit. The Croton Aqueduct, heading in an artificial lake 40 miles north of Manhattan, was the modern counterpart of Claudia and Anio Novis and the other aqueducts of the city on the Tiber.

Frontinus had his troubles with farmers who persistently encroached upon the right of way; and so did Craven. When the Croton Aqueduct was constructed, the land purchased by the city was not fenced, and "in many cases the shrubs and trees of the fine country seats through which the conduit passed were allowed to stand to the very edge of the excavation." There had been a very good reason for this; in those days the proprietary rights of the city were not clearly defined, and it was necessary to conciliate the landowners, who considered the condemnation of their land as a great hardship, with as little friction as possible. But it was not long before tree roots began to penetrate the masonry and work considerable damage, and to avoid any further injury, the Department "ordered the land in its charge to be entirely cleared of trees and shrubs and also commenced to put up fences. Considerable opposition arose," the fences were torn down, and "malicious attempts were even made to injure the retaining walls by removing stones." (Eighteen hundred years before, Frontinus had been on the lookout for similar mischief-makers.) The Department finally established the city's right to fence its property, after a fight that went to the higher courts.

From Frontinus to Craven, it does not seem that anyone had learned to build a strictly leakproof conduit. The Croton Aqueduct for 20 years (until 1862) required only trifling repairs; but about that time leaks became frequent. During the last six years that Craven served as commissioner, a total of almost 30,000 lin ft of cracks was discovered and repaired. It should be added that it was no reflection on the work of Jervis and Allen, the builders of the aqueduct, that these leaks occurred. That they did not develop earlier and to a greater extent is, rather, a witness to the care with which the embankments had been compacted and the masonry laid up.

Frontinus chased down many a water thief in Rome; Craven had less malicious persons to deal with, perhaps, but the persistent water wasters of New York were no less a nuisance. Servants and children made a pleasant pastime of sprinkling the streets; people let the water run all night in cold weather to keep the pipes from freezing; every alderman had the right to issue permits for access to the hydrants. When the aqueduct was designed, it was thought that 30,000,000 imperial gal per day would suffice for many years; but by 1850 the daily demand amounted to 40,000,000 gal, and the city was growing by leaps and bounds. It was necessary twice a year to shut down the conduit for inspection, and so nearly did the consumption approach the capacity of the line that it required months to refill the two reservoirs—whose total capacity was only 171,000,000 gal—after these inspections.

In his 19 years as commissioner, Craven saw New York grow from half a million to more than 900,000. The complete story of how the department kept pace with the increasing demands of the city during that period is far too long to tell here. Suffice it to say that Craven supervised construction of the large receiving reservoir in Central Park; the enlargement of the High Bridge crossing of the Harlem River—the bottleneck of the original aqueduct, whose improvement doubled the capacity of the conduit; and the laying of many miles of additional mains throughout the city. He also directed additional surveys of the Croton watershed and initiated construction of the high-service tower and reservoir at High Bridge and the Boyd's Corners Reservoir on the west branch of the Croton River.

One more comparison should be drawn with the Roman commissioner. Frontinus' code of ethics was strict; he was intolerant of sloppy workmanship and unceasingly conscious of his obligation to the city. Craven's sense of duty was no less keen. When the Common Council attempted to have some sewer work paid for which the Croton Department would not accept, as the contract had not been complied with, Craven wrote to the *New York Tribune:*

"As chief engineer and one of the heads of this department, I am placed here in charge of certain interests of the people generally of this city. If by any illegal or corrupt act injustice be done to them in any matter in the most remote degree connected with this department, I deem it due to them and myself not to be content with the mere requisition of the law to perform, but my full

Embark on in Rhode Island if $100,000 Were Made Available with

100% Highest Grades of Membership

duty in the protection of their rights and in the preservation of the integrity of the department on which they rely; and I do so with a full sense of my responsibilities, personally and officially."

Craven resigned from his post as commissioner in 1868, and after touring Europe with his family returned to New York and set up in private practice as a consulting engineer.

During his term as commissioner he had engaged in several tilts with McAlpine on the proposal for subways. Craven considered that the installation would play havoc with his streets and pipes, and firmly opposed, apparently, even McAlpine's plan to drive the tunnels by shield far below the street level. After he began his private practice he was engaged by the Gilbert Elevated Railroad as consulting engineer, and had a part in the planning of the Sixth Avenue and Second Avenue elevated lines.

Craven was elected President of the Society in 1869 and served for two years. While his fame as an engineer has perhaps been overshadowed by that of his predecessor McAlpine and his successor Allen, his contribution to the Society and to the promotion of a professional attitude among engineers was none the less important. He had been identified with the very first efforts to form an American engineering society—at Baltimore, in 1839. He had been among the founders of the present Society and had presided at its first meeting, which by his invitation was held in the offices of the Croton Aqueduct Department. He had also served a term as Director before his election to the presidency. He earnestly promoted the Fellowship Fund and encouraged the submission of papers; in this connection two quotations from his inaugural address may be of interest:

"Original papers form the main, if not the only, reliable food for the permanent health of our Society. They are the substance; the discussions which follow are the gastric juice which helps that substance to assimilate with the system and nourish the body.

"To each man of property in the country the advancement of engineering science is a matter of personal pecuniary interest; for the value of his investments, whether in established works or in the prosecution of new enterprises, rises or falls with the intellectual and moral worth of the engineer who plans and carries out the constructive operations."

Craven died in England, March 27, 1879, at the age of 68. He left no sons; a nephew, however—the late Alfred Craven, M. Am. Soc. C.E.—in his turn served the City of New York as an engineer for many years. The nephew, it is interesting to note, directed the construction of a section of one of the first subways—the project his uncle had strenuously opposed a generation before.

[Quotations describing the work of the Croton Aqueduct Department are from Wegman's *Water Supply of the City of New York*. Other quotations are from Society publications.]

A Large-Scale Reproduction of the Society Seal

An authentic enlargement of the seal of the Society, 17 by 21 in., now hangs in a corridor of the civil engineering department at the Carnegie Institute of Technology. It was prepared by members of the Student Chapter at that institute and was first displayed at the institute's annual public exhibition on the evening of April 24, 1936.

In securing an accurate reproduction, the first step was to turn to page 99 of the February 1934 issue of Civil Engineering. On that page appears a reproduction taken from the official drawing according to which the dies are made to produce the badges worn by members of the Society. This reproduction shows the badge about 3 in. in width. It was enlarged by the photoprint process in two successive steps, the first to $8^1/_2$ in. wide, and the final one to 17 in. The shield and lettering were then traced on a large sheet of tracing cloth, and the title "Student Chapter, Carnegie Institute of Technology" was lettered below. A simple border completed the work. From the tracing a Van Dyke negative was made and from this the final prints were taken. The edge of the shield and the lettering are blue on a white background. This is more legible for the purpose than a facsimile of gold on blue.

Upon request from Society Headquarters, Charles B. Stanton, M. Am. Soc. C.E., professor of civil engineering at the Carnegie Institute of Technology, forwarded a statement written by the students who did the job. After explaining the method used, the statement continues: "This authentic reproduction . . . was felt to be needed to designate further the Chapter's activities with the Society. This reproduction now adorns the corridors of the Department of Civil Engineering as a pledge to serve the interests of the Society and to acknowledge the benefits that Carnegie Institute of Technology has shared in the Society's activities."

The enlarged seal has attracted very favorable attention from all who have seen it. The idea was well conceived and executed and is a credit to the members of the Chapter who did the work. In fact, it has attracted so much favorable attention that upon request the Chapter furnished to Society Headquarters a negative from which prints will be taken for possible use at Society meetings around the country, such as in hotel lobbies, meeting rooms, and so forth. The Society is glad to acknowledge heartily the courtesy of the Carnegie Chapter in this respect.

With the foregoing information on details it should be practicable for any Chapter to produce a very creditable enlarged seal for similar purposes.

Providence Junior Engineers Organize for Professional Development

In line with a suggestion made last fall by Gen. R. I. Rees, chairman of the Committee on Professional Training of the Engineers' Council for Professional Development (E.C.P.D.), the Junior Engineers' Group for Professional Development of the Providence Engineering Society was organized on March 2, 1936. As plans mature and hopes are realized, it is expected that other centers of the engineering profession will try similar experiments.

Following General Rees's exposition of the junior movement, a committee of twelve prominent engineers and educators of the Providence Engineering Society, with Alton C. Chick as chairman, distributed a preliminary questionnaire to 600 engineers not more than five years out of college and other young men definitely following lines of engineering activity. To form a nucleus for the organization, a selected group of 20 junior engineers was appointed, who chose as officers Robert Anthony, Jr. (Yale), chairman, Roger P. Condon (Massachusetts Institute of Technology), vice-chairman, and John R. Pearson (Rhode Island State), secretary-treasurer. In discussions relating to a program, this group agreed that personal contacts and self-expression were the two chief benefits to be derived from the proposed activities.

In the meantime 151 replies to the questionnaire have been received. These may be classified as follows: (1) Interested in papers for junior engineers, 129; (2) interested in group discussion, 145; and (3) interested in formal study, 136. Thirty-seven topics for group discussions were voted on, of which the most popular were (1) production control and time study, 39; (2) air-conditioning, 26; (3) personnel relations, 26; (4) marketing, 14. The most popular of the 35 suggested topics for formal study were (1) business law, 54; (2) public speaking, 43; (3) cost accounting, 23; (4) differential equations, 14; and (5) power-plant subjects, 8.

At the first general meeting, held April 20, and attended by 250 juniors, a program was proposed. At a subsequent meeting on May 4 a number of groups were set up, each with a junior engineer as a group leader. The management group is interested in manufacture and managerial technic. The power group is concerned with steam plants, Diesel power, and general plant engineering. A third group contains those who wish to discuss the general economic background of the Providence industrial area. The construction contingent will not carry on study through group discussion but will have a class in formal study. There is also a machine-design group. Other groups will be organized as the need arises.

Beginning next fall, it is proposed to engage the services of a lawyer to give a series of lectures on business law, including contracts and specifications. Twenty-five men are contemplating courses leading to the degree of master of engineering, probably at Brown University.

To provide a constructive basis for discussion, members will make contributions on certain topics or projects. For example, the machine-design group will start a study of springs and their uses; the power group hopes to assemble and tabulate useful information on combustion and air conditioning; while the economics group will consider such a project as "What Business to

Henny having been elected to membership in 1887. The list of

the improved mileage of highways of the country is showing

Embark on in Rhode Island if $100,000 Were Made Available with Which to Do It." This latter project may be expanded to include other groups because, if a manufacturing enterprise is decided upon as the solution, construction engineers may study the building problem, power engineers the power equipment, machine designers the design and adaptation of machinery, and the management group personnel problems, plant operation, and estimates of cost.

An interesting experiment in cooperative post-collegiate study has thus been launched by E.C.P.D., which is an agency for getting engineers and engineering organizations to develop themselves and the profession. The constituent bodies of E.C.P.D. are the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the Society for the Promotion of Engineering Education, and the National Council of State Boards of Engineering Examiners.

Some Aspects of the Growth of the Society

MORE THAN 19,000 engineers and student engineers are today affiliated with the Society in one grade or another. Very nearly one-third of this group is included in the highest membership grades, and another third in the intermediate grades, while the remaining third comprises Juniors and members of Student Chapters.

Some interesting observations can be drawn from the accompanying diagrams. Figure 1 indicates that, with the exception of the three "depression years" just preceding 1935, both the growth of the Society as a whole, and the increase in the number of members in the highest grades, have been continuous over the past 63 years. The sharp increase in the rate of growth that began in about 1898 is apparently largely due to a steady influx of younger men—mostly in the intermediate membership grades until 1922, and in the lower grades since that time. The effect of the Student Chapters in increasing the number of men entering the Society as Juniors is so obvious as scarcely to require special mention. It suggests the prospect of an even more rapid growth of Junior membership in years to come.

In Fig. 2, membership statistics have been presented in a different form, to show variation in composition over all the years or the trends in the growth of the different grades. The tri-linear chart needs little introduction to those who have worked, for example, with concrete proportioning or with alloys containing three metals, but its use in the present connection is rather unusual.

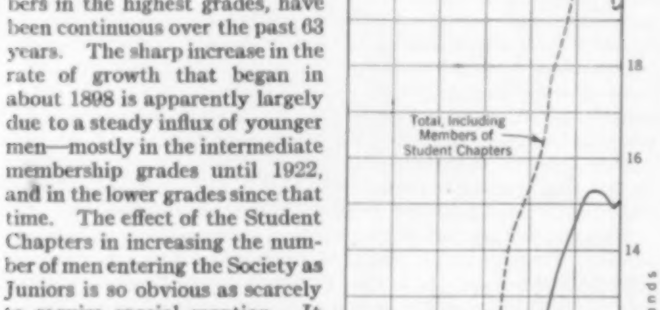


FIG. 1. SOCIETY MEMBERSHIP SINCE 1872

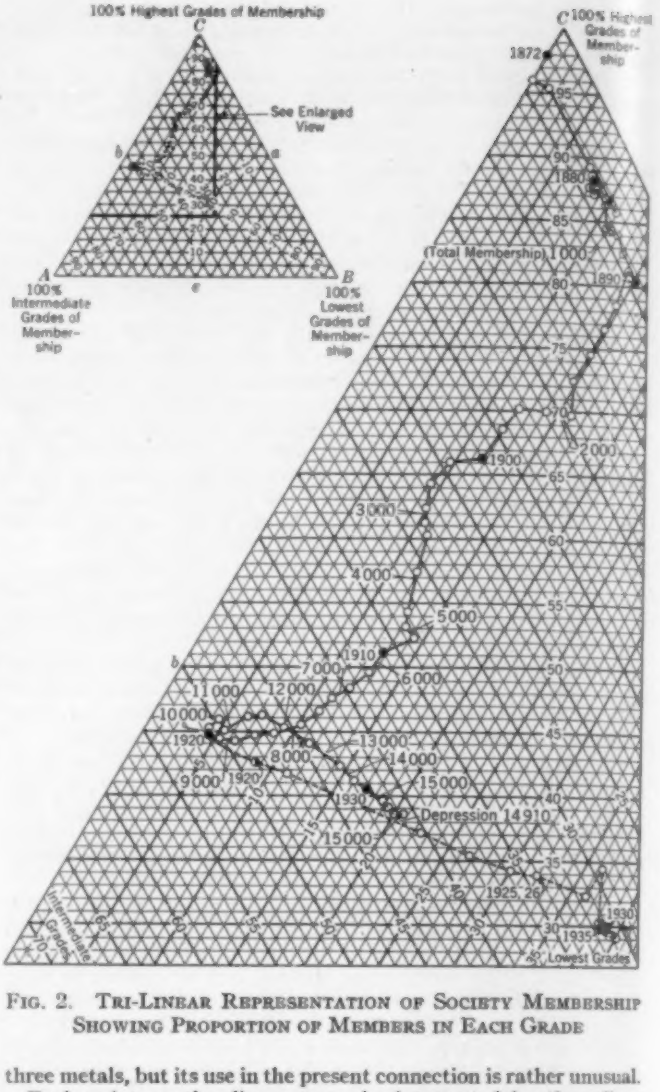


FIG. 2. TRI-LINEAR REPRESENTATION OF SOCIETY MEMBERSHIP SHOWING PROPORTION OF MEMBERS IN EACH GRADE

Each point on the diagram can be intersected by three lines parallel to the sides of the triangle, and the sum of the numbers on these lines is always 100. In other words, each point represents the percentage composition of a quantity made up of three different elements. In the present case, one can see, for example, that in the year 1900, 66 per cent of the membership of the Society was included in the higher membership grades, 22 per cent in the intermediate grades, and 12 per cent in the lower grades.

Three distinct trends will be noted. From 1873 to 1890 the percentage of Juniors was increasing, while the percentage of Associate Members remained nearly constant. Between 1891 and 1921 the Associate Members increased in number until they included more than half of all persons connected with the Society while the relationship of Members to Juniors held fairly uniform. Since that time the percentage both of Associate Members and of Members has dropped slightly, while the percentage of Juniors has increased.

As in Fig. 1, the dotted line beginning with 1920 represents the situation if members of the Student Chapters are taken into account. It will be noted that on this basis an almost exact balance among the three groups existed in 1925 and 1926, with the trend continuing since that time somewhat toward a predominance of the lower grades.

New Memoirs Available

MEMOIRS of ten Members and three Associate Members recently have been added to the number of preprints to be included in the forthcoming volume of TRANSACTIONS. In point of time, the list embraces 46 years of the Society's history, the late D. C.

Henny having been elected to membership in 1887. The list of memoirs, a limited number of which are available for free distribution, follows:

John Francis Cushing	1882–1935
Charles Wesley Erisman	1887–1934
Benjamin Curtis Donham	1873–1936
David Christiaan Henny	1860–1935
Vivion Rose Irvine	1885–1933
Harry Clifford McClure	1884–1935
Harry Ashton Roberts	1876–1935
James Wingate Rollins, Jr.	1858–1935
Henry Bedinger Rust	1872–1936
William Luther Sibert	1860–1935
Eugene Adalbert Silagi	1876–1935
Henry Clement Smith	1860–1936
George Stevenson Yates	1875–1935

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies Located in 40 States

Organization of Government Agencies

There are at present in Washington two movements which tend, in part, to offset each other, but about which very considerable will no doubt be heard during the next few months. On the one hand, there are groups of men within and without the government working on new plans for federal bureaus or departments which will take over the work of the emergency agencies which have, for one reason or other, been dropped. Some of the new plans take the form of setting up an over-all agency similar to the old NRA, and others take the form of special legislation such as the Ellenbogen bill for the control of the textile industry, which in essence is a "little NRA"; the Guffey bill for the control of the coal industry is similar in purpose.

On the other hand, three committees have been appointed to consider the possibility of consolidation and simplification of government organization—one by the Senate, one by the House, and a third by the President. The staff of American Engineering Council has been requested by the President's committee to confer with its staff and make suggestions, and the Brookings Institution has been provided with recommendations of earlier committees of Council with reference particularly to public works administration, mapping, and water resources.

A month of momentous decisions which may eventually lead to a general clarification of purposes and expedite the stabilization of government activities leaves many of the emergency and newer agencies in uncertainty and confusion.

The consequences of the Bound Brook decision by the Court of Appeals of the District of Columbia, declaring the use of relief funds for the construction of a suburban community unconstitutional, arouses an uncertainty about the use of relief appropriations for any but relief purposes. In the minimum wage decision, five members of the Supreme Court refused to amend the Constitution by taking away from the people rights which the people had reserved for themselves. One Justice thought the minimum wage law might possibly be upheld on the ground that women are entitled to special protection and three others insisted that state governments do not have the power to fix wages.

The Bureau of Public Roads

This bureau has completed a study of operating costs of vehicles in comparison with highway expenditures on all classes of roads in a number of northern states. They report operating costs per mile varying from 0.5 to 1.08 cents on city streets and from 0.83 to 3.1 cents on county roads and state systems. In some instances the actual saving accruing to operators of vehicles from the conversion of dirt roads to hard-surface highways has been as much as 3 cents per mile. On the basis of these findings, says the Bureau, the improved mileage of highways of the country is showing tremendous profits on the people's investment in them.

Special funds now available for repairing flood damage to roads and bridges on the Federal Aid System are estimated to be sufficient to pay the limit under the Hayden-Cartwright Act of one-half of such cost. State highway departments are familar with proper procedure.

In the recent transportation conference of the U. S. Chamber of Commerce, Director Thomas H. McDonald of the Bureau of Public Roads of the Department of Agriculture said, "Almost without exception it is the old-time structures that are most seriously damaged by floods and therefore replacement costs are partially chargeable to obsolescence. The severe winter caused more actual loss in the form of deterioration to low-cost road surfaces than flood damage. Large increases in mileage of low-cost public highways is certain to rapidly increase maintenance costs to a point where they may take the place of necessary new construction of the better class. Such a policy, although commendable within reasonable limitations, tends to destroy the logical and necessary step-by-step construction of a permanent highway system in states adopting it."

Public Health Service Reports Progress

Closer coordination of the health activities of federal, state, and local governments by the public health section of the Social Security Act under the direction of the surgeon general of the U. S. Public Health Service is reported to have increased the number of local health units from 540 to 715 in 3,000 counties. Eleven states have set up new units for the study of industrial hygiene. Nineteen states have established a central authority for the promotion and supervision of local health administrations. Thirty-one states have strengthened the engineering departments of their health services and 27 have improved their laboratory facilities. Under the act, each state is allotted a flat $3,268. Further allotments are being made on the basis of population, special health problems, and financial conditions. The states are given the opportunity of obtaining aid by matching federal allotments and new appropriations. For these purposes $3,333,333 has been made available under the Social Security Act, and $40,000,000 has been appropriated by participating states and local political subdivisions.

Emergency Construction by the Treasury Department

Under the Act of June 19, 1934, the Treasury Department has a total of 361 projects, with allotments amounting to $65,990,044. Ninety-two of them are complete and 194 are under construction. Allotments for 367 projects totaling $59,603,879 have been made against the $60,000,000 program provided for in the act of August 12, 1935. Sixty-two of them are under construction. Definite commitments have been made for sites, plans, and specifications for all other projects in these programs. Exact figures are not available but it appears that less than 5 per cent of this work has gone to engineers and architects in private practice.

Public Works Administration

Activities of this agency, involving commitments of billions in grants and loans, have only obligated it to accept $828,047,864 in bonds from states, counties, municipalities, and other borrowing bodies. That fact indicates that large purchases of such bonds must be made as construction progresses. Of the $543,764,734 actually purchased to date, $406,843,571 have been sold to RFC. Since the funds realized from the sale of such bonds by PWA may be used to buy more bonds from borrowing bodies, it is evident that any substantial appropriation for "grants" by this Congress will assure the continuation of a very substantial PWA program.

According to the F. W. Dodge Corporation, publicly financed construction work of the class benefited by the Public Works Administration has doubled its volume of a year ago—a new high since the depression. The total for April, both public and private, in 37 eastern states was $780,627,600, of which public projects accounted for 54 per cent of the total value. That means that private construction has reached the highest figures in five years, but it is still only a fraction of its normal volume.

The Power Division of PWA reports 112 of 132 communities in 32 states have recently voted to assess themselves for publicly owned utilities. It is interesting to note that 28 of these communities have less than 1,000 population, 28 have less than 2,000,

35 have less than 5,000, 21 have less than 10,000, and only 56 per cent of those above 10,000 voted for publicly owned utilities. Seventy-four of the older public utility projects are complete and 108 are under construction. Sixty-two projects in 26 states are delayed by litigation. Of them 39 are under restraint in the Federal Court of the District of Columbia.

Rural Electrification Administration

This agency now has a permanent status. It reports accelerated expansion of loans to both private utilities and cooperatives, but the total loans in the first year for the entire 76 projects involving approximately 12,000 miles of line, to serve about 40,000 customers in 25 states, were only $12,331,412.

Since REA funds are only advanced to sponsors as economic, legal, and engineering requirements are satisfied, it must be admitted that the services of practical engineers are essential to the success of the program. It is our observation that many engineers who have already been tested by rough experience are available.

Legislature and Government Regulations

Political considerations are controlling a majority of the final actions of the Seventy-Fourth Congress. Formal legislative procedure was interrupted by the recess but important committees are working behind the scenes to get the "unfinished but necessary business" ready for the quick enactment of a large amount of legislation during the few working days remaining in this session. All the "big" bills are in conference stages and are likely to move smoothly in the rush to campaign fields with the exception of taxation, which may require pressure from the Chief Executive. In the meantime, government regulations' changes are awaiting appropriations and the enactment of authorizing legislation.

Flood control legislation is still active. Congress yielded to pressure exerted by the U. S. Flood Control Federation which brought 500 delegates, who had gotten their feet wet in recent floods, to a meeting in Washington while the bills were in the committees. As a result, the Omnibus and Mississippi bills are awaiting the President's signature.

Work relief legislation, with its allied measures included in the deficiency appropriations, is scheduled for favorable action, although the House may stop the Florida Canal and reduce the appropriation for grants by PWA.

Engineering Employment Situation

All engineers seeking employment should know that there is an excess of engineers, as well as other employees at this time, in government service. Many, particularly in the emergency agencies, are kept on government payrolls as long as funds are available to provide them with a subsistence until they can find an opportunity to make a living somewhere else.

A very few vacancies are available at almost all times but there is keen competition among engineers in the service as well as from the outside for them. Those on the inside have the advantage of experience and the influence of personal acquaintances, even though they may not be as well qualified for the positions.

The most promising prospect, at this time, for the expansion of engineering employment in government service is with the REA. Most of the opportunities will be with the borrowing bodies in those states participating in the programs and with contractors and supply houses who go after rural electrification business.

It is obvious that many engineers in government service will soon have to find work in private employment and practice, and that those who are first to make the change are likely to get the better opportunities. The need in private industry is not confined to engineering in the technical sense. The steel and automotive industries have found it most advantageous to have engineers in management and in the councils of directors, and business and industrial executives are taking on competent engineer executives. Engineers seeking such responsibilities should choose employment in progressive organizations where there is evidence of genuine desire to make full use of their administrative ability as well as their technical qualifications.

Exhibit at the National World Power Conference

At the request of O. C. Merrill, director of the Third World Power Conference, and under the supervision of the committee on publicity for the engineering profession of American Engineering Council, an exhibit of the activities of the professional engineering organizations of the United States and of their instrumentalities will be staged in the Mayflower Hotel during the Third World Power Conference meetings to be held in Washington, D.C., September 7 to 12, inclusive.

Against the pictorial background of engineering development of the United States will be presented a picture of the scope and activities of the national, state, and local engineering societies, together with a statement of the objectives of the national organizations and of the functional organizations which they support, including United Engineering Trustees, Inc., Engineering Societies Library, the Engineering Foundation, American Standards Association, Division of Engineering and Industrial Research of the National Research Council, Engineering Societies Employment Service, Engineers' Council for Professional Development, and American Engineering Council.

Survey of Engineers

The June number of the *Monthly Labor Review*, published by the U. S. Department of Labor and issued the third week in June, will contain the first summary of the statistics from the "survey of engineers" conducted in August and September 1935 by the Bureau of Labor Statistics under the supervision of the committee on engineering and allied technical professions of the American Engineering Council in cooperation with more than 100 national, state, and local engineering societies. More than 60,000 questionnaires were returned to the Bureau for classification and codification. This is the first professional survey undertaken by the Bureau, and the returns represent the largest sampling of the engineering profession ever made. The article briefly summarizes the number of engineers in each of the branches of the profession, where they were employed as between government and private industry, and the interrelation between their educational training and the positions held.

Washington, D.C.
June 15, 1936

Appointments of Society Representatives

Thaddeus Merriman, M. Am. Soc. C.E., was recently reappointed a Society representative on the Hoover Medal Board of Award for the six-year term from May 1936 to May 1942.

Robert Ridgway, Hon. M. Am. Soc. C.E., has been appointed chairman of the Alfred Noble Prize Committee to fill the vacancy caused by the resignation of George B. Pillsbury, M. Am. Soc. C.E.

James F. Sanborn, M. Am. Soc. C.E., chairman; Robert Ridgway, Hon. M. Am. Soc. C.E.; and John H. Cook, Carleton E. Davis, Alfred D. Flinn, George G. Honness, Thaddeus Merriman, Walter E. Spear, and Frank E. Winsor, Members Am. Soc. C.E., have been appointed a committee to prepare a memorial volume on the late J. Waldo Smith, Hon. M. Am. Soc. C.E.

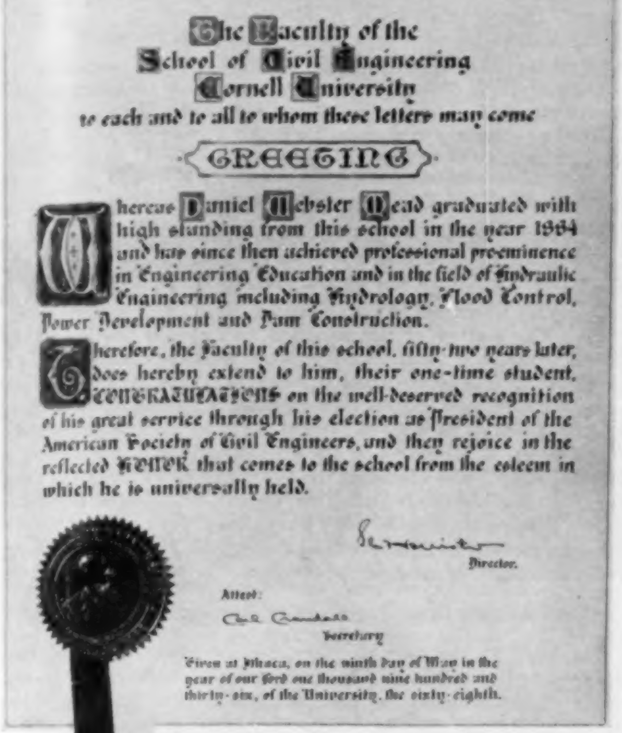
George T. Seabury, Secretary of the Society, will represent the Society on the newly created State Public Affairs Contact Committee of the American Engineering Council.

Homer R. Seely, M. Am. Soc. C.E., will represent the Society on the Sectional Committee on Standardization of Graphical Symbols and Abbreviations for Use on Drawings.

In and About the Society

Each issue of Civil Engineering is as interesting and as useful to our members as the best efforts of the editorial staff can make it. Some numbers, however, prove more popular than others. This is particularly true of the April 1936 issue, of which the entire supply has been exhausted in filling additional orders.

The congratulatory resolution recently presented to Daniel W. Mead, President Am. Soc. C.E., by the faculty of the school of engineering of Cornell University, is an unusual and distinctive award. Cornell grants no honorary degrees, and a recognition like



The Faculty of the
School of Civil Engineering
Cornell University
to each and to all to whom these letters may come

GREETING

Whereas Daniel Webster Mead graduated with high standing from this school in the year 1884 and has since then achieved professional preeminence in Engineering Education and in the field of Hydraulic Engineering including Hydrology, Flood Control, Power Development and Dam Construction.

Therefore, the Faculty of this school, fifty-two years later, does hereby extend to him, their one-time student, CONGRATULATIONS on the well-deserved recognition of his great service through his election as President of the American Society of Civil Engineers, and they rejoice in the reflected HONOR that comes to the school from the esteem in which he is universally held.

Director.

Attest:

Secretary

Given at Ithaca, on the ninth day of May in the year of our Lord one thousand nine hundred and thirty-six, of the University, the sixty-eighth.

Resolution Presented to Daniel W. Mead, President of the Society, by Faculty of School of Engineering, Cornell University

that accorded Dr. Mead is said to be the highest honor in the power of the faculty to confer. The presentation took place at the conclusion of the joint regional conference of Local Sections and Student Chapters at Ithaca, N.Y., on May 9, 1936.

News of Local Sections

Colorado Section

Members of the University of Colorado Student Chapter were guests of the Colorado Section at its regular meeting held on May 11. Before dinner a motion picture on the construction of Grand Coulee Dam was shown at a local theater. The program of the meeting, which followed dinner, was arranged to give the Student Chapter members an idea of the present activities of various governmental agencies. The list of speakers included C. P. Ames, substituting for George M. Bull, acting state director of the Public Works Administration in Colorado, who was unable to be present; Frank M. Keller, state engineer inspector for Colorado, Utah, and Wyoming; C. T. Henderson, supervising engineer for the Mineral Resources Division of the U. S. Bureau of Mines; J. L. Brownlee, regional engineer of the U. S. Forest Service; and R. A. Klein and P. J. Preston, of the U. S. Bureau of Reclamation.

The Association of Junior Engineers of the Colorado Section held its last meeting of the season on May 25. On this occasion the speaker was E. A. Abdun-Nur, a graduate of Massachusetts Institute of Technology, who is now an engineer in the Denver Water Department. Mr. Abdun-Nur described present engineering practices in Syria, his native land, which he has recently visited.

Detroit Section

On May 22 the Detroit Section held a meeting at the Hotel Statler, which was attended by 35 members and guests. The technical program included a talk by Harold C. Hickman, inspector of dredging for the U. S. Army Engineers, who described the hydrographic survey of Rainy Lake. There was also an illustrated lecture on "The Historical Development of Suspension Bridges," which was presented by A. A. Jakkula, of the department of civil engineering of the University of Michigan. Both papers elicited considerable discussion.

Georgia Section

A luncheon meeting of the Georgia Section was held in Atlanta on May 11. T. J. Durrett, Jr., of the program committee, commented on the fact that WPA projects in Georgia are in good shape. He then introduced the speaker of the occasion, R. L. McDougall, chief engineer of the Works Progress Administration in Georgia. Mr. McDougall discussed the local highway situation and spoke of the difficulty of obtaining skilled labor on the fourteen airport projects now under way in Georgia.

Illinois Section

There were 28 present at a luncheon meeting of the Illinois Section which was held on May 12. The speakers on this occasion were W. W. De Berard, associate editor of the *Engineering News-Record*, and Field Secretary Jessup. Mr. De Berard discussed the metropolitan housing situation, and Mr. Jessup spoke on the financial status of the Society and on the current activities of Juniors and Student Chapters.

Indiana Section

The Indiana Section held a luncheon meeting on May 14 in honor of the Student Chapter members from Purdue University and Rose Polytechnic Institute who have been chosen to receive the 1936 awards of the Section for outstanding college work. Field Secretary Jessup was present and gave a résumé of Society activities during the past year. There were 34 present.

Los Angeles Section

A joint meeting of the Los Angeles Section of the Society and the California Institute of Technology Student Chapter, which was held in Pasadena on May 13, attracted an attendance of 245. During the afternoon the hydraulic and optics laboratories of the university were thrown open for inspection. Naturally special interest was shown in the giant mirror for the 200-in. reflecting telescope to be erected at Mt. Palomar. Preparations for polishing this mirror, which was recently cast, are now complete, but it is expected that the process will take four years. Dr. John Anderson, in charge of the operation, was present to answer questions about the project. After dinner, which was served beneath the olive trees of Dabney Garden, the meeting adjourned to Culbertson Hall, where papers were given by three graduates of the institute on subjects they are investigating. These speakers were Arthur Ippen, teaching fellow and assistant in hydraulics at the California Institute of Technology, who described the work being done under the auspices of the Los Angeles County Flood Control District in studying the flow of water at high velocities due to abnormal gradients in curved channels; Mark Serrurier, structural designer at the institute, who discussed the reasons for the selection of remote Mt. Palomar as the site of the location of the 200-in. telescope; and James Jennison, who discussed the effect of earth shocks on the upper floors of buildings.

Members of the Los Angeles Section have derived both pleasure and profit from participation in the weekly luncheon meetings of the Los Angeles Engineers' Club. Members of any of the technical societies are eligible to attend these luncheon meetings.

Louisiana Section

During the past year the Louisiana Section held technical meetings on April 18 and May 29, 1935, and January 24, 1936. The speakers on these occasions were Capt. John P. Dean, Gen. Harley B. Ferguson, and John Klorer, chief state engineer. There were 42 present at a meeting of the Section held in New Orleans on April 15. Numerous business matters were attended to at this session, including the election of officers for the coming year. The

results of this election were published in the June issue of CIVIL ENGINEERING. Possible changes in the constitution of the Section were discussed during the business meeting. The technical program consisted of a talk by Col. F. B. Wilby, whose subject was "The Use of Asphaltic Concrete in the Repair of Jetties." This address, which was illustrated, elicited considerable discussion. Refreshments and a social hour were enjoyed after the meeting.

MARYLAND SECTION

Faculty and student representatives from the University of Maryland and Johns Hopkins University were among the large number present at a meeting of the Maryland Section held at the Engineers' Club in Baltimore on May 22. The nature of the occasion was the annual presentation of prizes consisting of Junior membership in the Society to two Student Chapter members. Plans were made at this time for the publication of the two winning theses in *The Baltimore Engineer*, the local organ of the engineering profession. The business session included discussion of the proposed law for the registration of professional engineers and land surveyors in Maryland. At the conclusion of the business meeting refreshments were served, and a social hour was enjoyed.

METROPOLITAN SECTION

At the annual meeting of the Metropolitan Section, which was held in the Engineering Societies Building in New York on May 20, the following officers were elected: Leslie G. Holleran, president; Harry D. Winsor, vice-president; William J. Shea, secretary; and George W. Burpee, Victor Gelineau, and Ernest P. Goodrich, directors. The other officers on the Board of Direction for 1936–1937 are E. M. Van Norden, vice-president; J. S. Langthorn, treasurer; R. E. Bakenhus, C. W. Bryan, Jr., and William Heyman directors; and Ole Singstad and Van Tuyl Boughton, former presidents. As part of a symposium on the subject of what the Society is doing for its members, Secretary Seabury gave a talk on its recent activities in regard to employment. Then Ernest P. Goodrich, chairman of the Society's Committee on Salaries, presented some of the outstanding findings of that committee. Following this program, the Junior Branch of the Section conducted the finals in its annual effective speaking contest. First prize was awarded to Richard H. Ludeman, and second to Don Johnstone. Refreshments were served at the close of the meeting.

The Junior Branch concluded its season with a dinner meeting on May 26. The program consisted of an extemporaneous one-minute speech by each person present. The Branch then elected officers for the coming year, the list being as follows: George L. Curtis, president; Don Johnstone, first vice-president; Alfred Africano, second vice-president; George G. Hayden, secretary; and Sidney M. Marks, treasurer.

NASHVILLE SECTION

At a meeting of the Nashville Section, held on May 14, the following new officers were elected: A. J. Dyer, president; R. N. Coolidge, vice-president; and S. A. Weakley, secretary.

NEBRASKA SECTION

There were 26 present at a joint meeting of the Nebraska Section and the University of Nebraska Student Chapter held at Lincoln on May 14. The speakers were T. A. Leisen, Director of the Society, who discussed the aims and activities of the Society; John Latenser, Jr., state director of the Public Works Administration, whose topic was "Some Aspects of the Public Works Program in Nebraska"; and Roy Green, president and manager of the Western Laboratories, Inc., who outlined the action under way to secure the passing of an engineers' registration bill at the coming session of the legislature. A representative of the University of Nebraska Student Chapter also gave a talk.

NORTH CAROLINA SECTION

The annual meeting of the North Carolina Section, which was held in Pinehurst on May 2, took the form of an all-day session. The speakers on the program were D. S. Abell, president of the Section; A. Wray White, member of the North Carolina State College Student Chapter, who discussed the relationship between the Local Section and the Student Chapter; J. A. Muncy, an engineer with the Soil Conservation Service, who described the soil-erosion program in the Piedmont and mountain regions of North Carolina; Dr. W. J. Lancaster, medical director of the Atlantic Coast Line Railroad Company, whose topic was the necessity for closer cooperation between the physician and the engineer; H. D. Hamrier, of the General Electric Company of Raleigh, N.C., who gave an illustrated talk on "Safe Seeing and Safe Driving"; and T. T. Betts, division engineer of Fayetteville, N.C., who described the repair of North Carolina highways after the recent winter floods. During luncheon R. S. Henry, assistant to the president of the Association of American Railroads, was the speaker. The business meeting, which was held in the afternoon, resulted in the election of T. C. Atwood as president and G. H. Maurice as vice-president. B. W. Davis will continue as vice-president, and Harold C. Bird as secretary-treasurer, D. S. Abell, retiring president, becomes a member of the board.

NORTHEASTERN SECTION

There were 39 present at a meeting of the Northeastern Section, which was held on March 12. The business session included discussion of a proposed bill for the registration of engineers and of the possible formation of Local Sections in Maine and New Hampshire. The feature of the program was a talk on the subject, "Adventures of a Civil Engineer in Other Countries." This was given by Dr. Karl von Terzaghi, a member of the staff of the Technische Hochschule. A luncheon meeting of the Section was called to order on May 16, with 42 present. The speaker on this occasion was Edward L. Moreland, of the firm of Jackson and Moreland, of Boston, Mass., who discussed the system of police signals in use in Boston. The members were then taken on an inspection trip to police headquarters in Boston, where they were given an insight into the method of handling emergency calls, the teletype system, radio broadcasting, and similar features.

NORTHWESTERN SECTION

On April 21 the Northwestern Section held a meeting in the Minnesota Union Building in Minneapolis. There were 17 present. After a brief business session E. V. Willard, commissioner of conservation for the state of Minnesota, gave an interesting talk on the engineering phases of the state conservation program. Following his talk, there was considerable discussion of the fact that ground-water levels in the state have been lowered during the past few years. Possible early depletion of the high-grade iron ore deposits of the state was also discussed.

PHILADELPHIA SECTION

Meeting the emergencies that arose as a result of the floods in March of this year was the subject discussed at a meeting of the Philadelphia Section held on May 20. There were 48 at the dinner, and 85 at the meeting following it, which was under the chairmanship of Harry S. R. McCurdy. The first speaker in the symposium was Robert Spurr Weston, consulting engineer of Boston, who compared New England flood conditions existing in March of this year with conditions in the spring of 1927. Mr. Weston showed two reels of motion pictures taken in different sections when the flood was at its height and also after its subsidence. Then W. L. Stevenson, chief engineer of the Pennsylvania State Department of Health, gave a graphic account of the emergency measures adopted to prevent the spread of disease during and after the flood. The last speaker was J. D. Carpenter, of Gannett, Eastman, and Fleming, of Harrisburg, Pa., who described how that city was kept supplied with water in spite of the fact that the pumping station was completely inundated. The closing event of the evening was the award of prizes to Student Chapter members in the annual student essay competition.

SACRAMENTO SECTION

During March and April the Sacramento Section continued to hold weekly luncheon meetings. On March 3 the members heard L. B. Cheminant, office engineer for the San Francisco Utilities Commission, trace the history of the Hetch Hetchy water development. The meeting held on March 10 was devoted entirely to business. On March 17 Floyd Rose, state safety officer for the Public Works Administration, presented statistics on accidents on construction work in California and outlined methods of decreasing the number of such casualties. Following this talk, Joseph W. Gross gave a brief description of his recent trip east and a report on the Annual Meeting of the Society, which he attended. On

March 24 the speaker was A. G. Mott, director of the valuation division of the State Board of Equalization, and on March 31 Courtlandt Eaton, who is with the U. S. Bureau of Reclamation, presented a paper on erosion and erosion control in Los Angeles County. At the meetings held during April the speakers were H. B. Walker, professor of agricultural engineering at the University of California; Walker R. Young, construction engineer for the U. S. Bureau of Reclamation; Frederick H. Tibbetts, consulting engineer of San Francisco; and Frederick J. Klauss, city engineer of Sacramento. The attendance on these occasions ranged from 24 to 72.

San Diego Section

On April 19 the San Diego Section of the Society and the Engineers' Club of San Diego motored to the All-American Canal Project now under construction in the Imperial Valley. R. B. Williams construction engineer on the project, and his assistants conducted the party to the site of the diversion dam. They were then taken along the canal, where they saw huge draglines cutting a canal through the sand dunes. On April 23 the Section and the Engineers' Club held a joint dinner meeting in the Army and Navy Y.M.C.A. The feature of the occasion was an illustrated talk on the All-American Canal Project, which was given by Mr. Williams. The fact that this talk came so soon after the inspection trip made it especially interesting. There were 42 at the meeting.

Seattle Section

The annual joint meeting of the Seattle Section and the University of Washington Student Chapter was held at the University of Washington Commons in May. Papers were presented by the following students: H. N. Wallin, whose subject was the Golden Gate Bridge; W. L. Shannon, who spoke on the bearing power of piles; I. D. Morris, who discussed earth dams; and W. C. King, whose topic was the stabilization of earth roads. The annual award of student prizes was then made by the Section.

Syracuse Section

The Syracuse Section entertained the senior class members of the Syracuse University Student Chapter at their annual meeting, which was held at the Onondaga Hotel on May 12. At this session officers for the coming year were elected as follows: F. D. McKeon, president; W. F. Kavanaugh, first vice-president; E. F. O'Brien, second vice-president; G. P. Dunn, secretary-treasurer; and S. D. Sarason, director.

Tacoma Section

A meeting of the Tacoma Section was held at the Tacoma Hotel on May 11, with 25 members and guests present. During the business sessions B. P. Thomas gave the report of the Engineers' Joint Legislative Committee, sponsor of the engineers' registration act recently passed by the Washington state legislature. The technical program consisted of a talk by Dr. T. G. Thompson, of the oceanographic laboratory of the University of Washington. Dr. Thompson's subject was the activities of the personnel and crew of the yacht, *Catalyst*, seagoing laboratory of the university, during 30,000 miles of cruising in the waters of Puget Sound and the Pacific. An enthusiastic discussion followed.

Utah Section

Members of the Utah Section met in Ogden on May 23 for a combination luncheon, inspection trip, dinner, and evening meeting. Luncheon was served at the plant of the American Concrete and Steel Pipe Company. Later the group was shown through the plant and watched the manufacture of centrifugally spun reinforced concrete pipe for the city water-supply system. Under the direction of Claude Coray and Harry Irwin, respectively city engineer and water superintendent of the city of Ogden, a trip was then made to the newly constructed water-storage reservoir and to the supply line now being built. Next the group was conducted by engineers from the U. S. Bureau of Reclamation to the Ogden River reclamation project and to the site of Pine View Dam now under construction. In the evening, there was a dinner at the Ben Lomond Hotel. Following dinner John R. Iakisch, construction engineer for the U. S. Bureau of Reclamation, discussed the design, construction, and purpose of the Ogden River project. Mr. Coray then described the engineering features of the city water supply system and reservoirs.

Student Chapter Notes

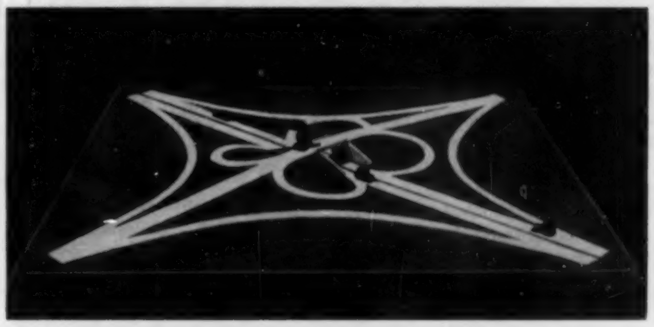
Case School of Applied Science

The Case School of Applied Science Student Chapter was host to the Cleveland Section and to the University of Akron Student Chapter at a dinner meeting held on May 21. In accordance with its annual custom, the Cleveland Section presented Student Chapter prizes on this occasion. The principal feature of the program was a series of short discussions by several senior students on the experimental problems described in their theses. At the conclusion of these discussions the guests visited the civil engineering laboratories of the school, where the experimental work was demonstrated by the students. Field Secretary Jessup was guest of honor at this session, which was attended by 48.

Texas Technological College

During the annual engineering show recently held by the Texas Technological College members of the Student Chapter exhibited interesting models of civil engineering projects. The list of models shown included a steel deck plate-girder railway bridge, a reinforced-concrete deck-girder highway, a highway traffic circle, a replica of Boulder Dam, a street intersection with a system of modern traffic signals in operation, and a reservoir and spillway. The accompanying illustrations show models of a suspension bridge and of a clover-leaf grade-separation project.

Model of Suspension Bridge



Model of Clover-Leaf Grade Separation
Made by Texas Technological College Student Chapter

University of North Dakota

Members of the University of North Dakota Student Chapter enjoyed a two-day trip to Winnipeg on May 8 and 9. En route by motor, the party visited the University of Manitoba and Manitoba Agricultural College, where they viewed the engineering buildings. In Winnipeg the features of interest that were inspected included water works, machine shops, hydro-electric plants, the Canada cement plant at Fort Whyte, the parliament building, the bridges across the Red and Assiniboine rivers, as well as other places of engineering significance.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for August

An article by Edmund W. Bowden, M. Am. Soc. C.E., assistant to the chief engineer, Port of New York Authority, on some major problems of design and construction of the Triborough Bridge, the $42,000,000 structure connecting three of the boroughs of New York City, which is scheduled to be opened on July 11, 1936, will be featured in the August number of Civil Engineering. The $3^1/_2$ miles of crossing structures include a 1,380-ft span suspension bridge over the East River having the unprecedented width for a two-cable bridge of 98 ft, a 350-ft truss span over the Bronx Kills, and a 310-ft vertical lift span over the Harlem River. A separate article on the latter structure, the largest of its kind ever built, is expected to appear in a forthcoming issue. O. H. Ammann, M. Am. Soc. C.E., chief engineer, Port of New York Authority, will write a foreword to Mr. Bowden's paper.

At the regional meeting of District 9 Local Sections, held in Columbus, Ohio, on May 15 and 16, 1936, addresses descriptive of a group of nearby engineering projects were delivered. Abstracts of a number of these papers will appear in the August issue, including, among others, one on constructing water works and sewers for villages, by E. A. Lawrence; another on the new city refuse incinerating plants, by Edward A. Ramsey; and a third on the Dublin bridge and highway separation project, by D. H. Overman.

A review of recent trends and developments in water works practice, by M. F. Trice, assistant engineer, North Carolina State Board of Health, is also scheduled for inclusion. Among these improvements may be mentioned the introduction of new chemicals for better flocculation and elimination of tastes and odors, increased efficiency of sand filter beds due to higher rates of backwashing, and prolongation of chlorine disinfecting action through the addition of ammonia.

If space permits, an interesting paper will be included on transportation for wildcat oil camps in Colombia, near the Venezuelan border, written by Robert Stephenson, Assoc. M. Am. Soc. C.E. Access to the oil concession could be had by river only during the three-month rainy season, and travel by land meant a 25-mile pack over a precarious trail from the nearest rail point. Tropical heat, fever-bearing insects, and hostile savages contributed to the difficulties of constructing the road and railroad necessary for transporting machinery and supplies.

John F. Stevens Honored

On May 21, 1936, a luncheon was held at the Engineers Club of New York to honor John F. Stevens on the occasion of his election as an honorary member of that organization. Mr. Stevens is also an Honorary Member of the Society, of which he served as President in 1927.

His accomplishments in railroad construction and operation led to his being sent to Russia during the World War as special railroad adviser to the Kerensky government. After the overthrow of Kerensky, and until the collapse of the Kolchak government, Mr. Stevens had complete charge of allied railroad operations in the Russian maritime provinces as president of the Inter-Allied Technical Board, representing Italy, France, England, United States, Japan, Russia, and Czechoslovakia.

These wartime experiences formed the subject matter of a very interesting talk by Mr. Stevens given in response to a tribute by Arthur S. Tuttle, Past-President of the Society, who presided. More than 75 engineers attended the luncheon.

Honorary Degrees Awarded

Each year honorary degrees are awarded to certain engineers who have made important contributions to the profession. Several members of the Society are among those thus honored during the current spring. The following list of those who have received such awards has reached Headquarters. Doubtless there are others of whom the Society has not yet heard.

Raymond E. Davis, Doctor of Engineering, University of Maine.

Edwin S. Fickes, Doctor of Engineering, Rensselaer Polytechnic Institute.

A. H. Fuller, Doctor of Science, Lafayette College.

C. C. Williams, Doctor of Engineering, Northeastern University.

Wise and Otherwise

As hot weather is in the offing, Professor Abercrombie has refrained this month from asking any very difficult conundrums. Instead the following trick submitted by Gavin Hadden, M. Am. Soc. C.E., is presented.

For example, you might tell a friend that you can give the result of an addition of nine four-figure numbers upon sight of the first one. You then ask him to write down the first number. He may write 4,682. You set down the answer, 44,678, on a separate piece of paper and lay it aside.

$$\text{The friend may write} \ldots \begin{cases} 4{,}682 \\ 2{,}537 \\ 6{,}419 \\ 7{,}392 \\ 5{,}086 \end{cases}$$

$$\text{You then dictate} \ldots\ldots\ldots \begin{cases} 7{,}462 \\ 3{,}580 \\ 2{,}607 \\ 4{,}913 \end{cases}$$

He finds the sum to be .. 44,678, as you predicted.

The explanation is simple. The sum is written down beforehand by adding 40,000 to, and subtracting 4 from, the first number, 4,682. The numbers dictated represent the respective differences between each of the latter four numbers set down by your friend and the number 9,999. The answer is then $(4 \times 10{,}000) - (4 \times 1) + 4{,}682 = 44{,}678$, as previously written. The trick may be further obscured by varying the order of the last four numbers. For five numbers, $(20{,}000 - 2)$ may be added, and so on, but if fewer than five numbers are used the method becomes too evident.

A second amusing device has come to the Professor's attention through a different source. Explain to a friend (a different one, perhaps) that you will determine his age and the number of dollars in his pocket (if less than 100) as follows. He is to double his age, add 5, and multiply by 50. To this product he must add his cash and subtract 365, the number of days in a year. When he gives you the correct result of these operations, add 115. The sum will then be a four-figure number of which the first two digits represent his age and the last two his cash. The explanation lies in the following equation:

$$(2A + 5)\,50 - 365 + C = N - 115$$

June's problem concerned a length of pipe, 24 in. in circumference, standing on end on which two insects, A and B, crawled spirally upward. A line drawn through their positions at any time remained vertical, but B took a steeper course than A and traveled 20 per cent faster. When the circuit of the pipe was completed, B was at the top while A was 11 in. below. The length of the pipe was required.

This problem is very simple, of course, involving solution of the quadratic equation $24^2 + (11 + x)^2 = 1.44\,(24^2 + x^2)$, where x = the height attained by insect A. The interesting point is that there are two real solutions, $x = 7$ and 43, and the pipe length may be either 18 in. or 54 in.

SIXTY-SIXTH ANNUAL CONVENTION, July 15–18, 1936, in Portland, Ore.

The Wreck of the Coast Survey Brig "Washington"

By R. R. Lukens, M. Am. Soc. C.E.,

Commander, U. S. Coast and Geodetic Survey, Washington, D.C.

The field officers of the U. S. Coast and Geodetic Survey are of necessity amphibious in their activities. The Survey operates ten sea-going vessels, all of which are commanded and officered by these engineers. With one exception, the vessels are of steel construction and range from the *Oceanographer* (the former yacht *Corsair*), 270 ft in length, to the *Gilbert*, 77 ft in length. All are equipped with modern devices for echo sounding, sound ranging, and radio communication.

The men are appointed from among the civil engineering graduates of our ranking technical schools and obtain their sea training after entering the service. The commanding officer is responsible for the safety and navigation of the ship as well as for laying out and supervising the surveying work of the party. The wardroom officers stand regular watches at sea and when on the working grounds are in charge of sub-parties working from the ship or from camps. Their daily work covers a wide field of sometimes thrilling activities, such as landing through the surf or climbing mountain peaks in the triangulation scheme.

But if the Survey's activities are thrilling and hazardous today, those of the days of sail were doubly so. Despite the utmost care, disaster sometimes befell. In the annals of the Survey, the most serious marine catastrophe in point of loss of life was the wreck of the brig *Washington*, 90 years ago.

The *Washington* was the first vessel to be assigned to the investigation of the Gulf Stream. She was apparently a fine sea boat and a smart sailer—though those who have done oceanographic work in the Gulf Stream with a well-found steamer can easily visualize the difficulties in the path of those oceanographers on the *Washington* who had neither mechanical propulsion nor suitable machines for sounding.

The *Washington*, in command of Lieut. George M. Bache, U.S.N., had finished a successful cruise and at the end of the season was returning to Norfolk, Va. Captain Bache had purposely discontinued work early in September because of the destructive hurricanes that frequently sweep this coast during that month.

During the evening of September 7, 1846, as the *Washington* approached the entrance to Hampton Roads, she encountered fresh breezes from the northward and eastward with a heavy swell from the southward. By midnight the breeze was fresh from the E.N.E. with thick and squally weather. Smith's Island Lighthouse was sighted but was lost almost immediately afterwards.

The brig was headed around and a course was laid for Cape Henry in the hope that that light could be picked up. But by 2:30 it had not been seen, and land was visible under the lee. This placed the *Washington* on a lee shore and of course in a dangerous situation. The commanding officer immediately wore ship and made all sail possible to the southward and eastward. By daylight the brig was laboring in heavy gales from the north and eastward. The jibboom was carried away, and both starboard boats filled and were torn away from the davits. By 10:00 a.m. it was blowing a hurricane and the ship was on her beam ends. The main-mast was cut away and the lee guns hove overboard. The vessel then slowly righted herself, but soon the fore-topmast and the foreyard were carried away and remained hanging up and down the mast.

The following is quoted from the ship's log: "Got her before the wind and hove overboard the larboard guns; sounded in eight fathoms of water, not able to see a cable length ahead; the tops of the seas blowing completely over and aboard us, the men clinging to keep from being washed overboard." Judging from the testimony of officers who survived the gale it was Captain Bache's plan to anchor the brig and then, in case the chains parted, to drive it ashore under the bare foremast. He considered that if the chains did not part, the brig would drag slowly and probably the wind would shift before the vessel got into the breakers.

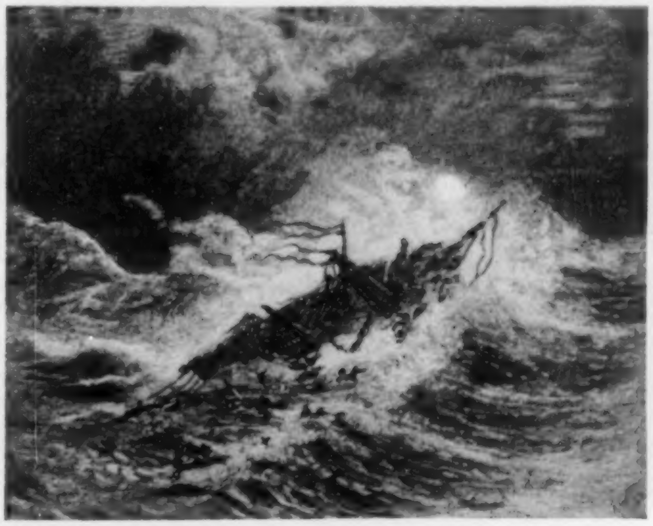
At 11:00 a.m., therefore, they let go the stream anchor with a $6^1/_2$-in. manila hawser 180 fathoms in length bent to it, in order to bring her head to the wind preparatory to anchoring.

While they were in the act of letting go the starboard anchor, the brig shipped a tremendous sea which carried before it everything and everybody amidships and on the quarter-deck. At this time Captain Bache was on the quarter-deck with three men at the wheel, and all were carried overboard by that overwhelming sea. The vessel partly righted herself and some of the men succeeded in getting back aboard but the commanding officer and ten men were lost. It was thought that many of them were injured and for that reason were more or less helpless in the water. Upon the loss of Captain Bache the command of the brig fell to Lieut. John Hall, U.S.N., whose subsequent actions won the praise of both the Coast Survey and the Navy Department.

As soon as possible after the sea was shipped the pumps were manned, the foremast cut away, and the anchor dropped. The brig was then brought head to the wind and with the hurricane abating she rode to her anchors. While everything both above decks and below was completely wrecked, the hull of the Washington remained tight and she stayed afloat.

During the next day heavy gales from

A Modern Coast and Geodetic Survey Ship
The *Surveyor*, Off the Alaskan Coast



The Wreck of the Survey Brig *Washington*
September 8, 1846

the N.N.W. continued and all hands were employed in preparing a jury foremast. That night a lighthouse (supposed to be Cape Hatteras) was sighted bearing S.S.W. From this it may be inferred that the vessel was somewhere off Nags Head, N.C., when the disaster occurred.

On September 10, the third day of the gale, the crew were so completely exhausted that they were permitted to remain below the entire day. On the following day they succeeded in getting some sail on the jury-rigged foremast and after heaving up the anchors, stood offshore. It was found that the anchor chain had parted about 10 fathoms from the starboard anchor. While the brig was at anchor after the hurricane several sailing vessels passed her. Some apparently did not see the distress signals and one which came fairly close refused to board her on account of the heavy sea.

September 13 being Sunday, divine services were held aboard the *Washington*. At 1:00 p.m. they spoke the brig *J. Peterson* bound from Wilmington, N.C., to New York. A contract was made with the master of the *Peterson* to stand by and convoy the *Washington* until arrival at some harbor between Cape Henry and Newport, R.I. The *Peterson* remained with the *Washington* for four days and furnished considerable equipment to enable the brig to rig more sail. On September 16, however, the *Peterson* disappeared and was seen no more. Whether this disappearance was by accident or design is not indicated in the log book of the *Washington*.

On the following afternoon a large sail was made out to the southward standing toward the *Washington*. This proved to be the U.S. Frigate *Constitution*, bound to Boston from Rio de Janeiro. Lieutenant Hall went aboard the *Constitution* and made arrangements for a tow. At 6:00 p.m. the *Constitution* took the brig in tow and sent aboard various supplies including 75 gallons of water and $7^1/_2$ gallons of whisky. As the crew had been on short water rations for several days it can be imagined how these supplies must have raised their spirits.

Four days later the *Constitution* and her tow arrived off the Delaware Capes. The *Washington* then took on board a Delaware pilot and stood for the river entrance in tow of the pilot boat *Enoch Turley*. After a short time the hawser was cast off and the brig proceeded up the river under her own sail, arriving at the Philadelphia Navy Yard on September 24.

In the Congressional Cemetery, Washington, D.C., there is a small monument erected to the memory of Lieutenant Bache and the ten men who lost their lives with him. The monument is in the form of the stump of a mast, symbolical of the dismasting of the *Washington*.

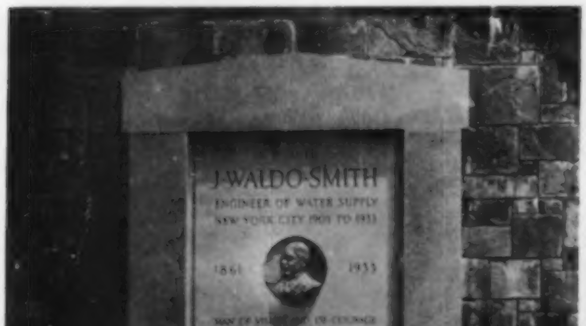
Memorial to J. Waldo Smith Dedicated

ON JUNE 25, as this issue goes to press, a memorial to the late J. Waldo Smith, Hon. M. Am. Soc. C.E., is being unveiled on a hilltop overlooking the Ashokan Reservoir of the New York water supply. Some four hundred friends and former associates of Mr. Smith have contributed to its erection.

The memorial—a granite tablet set in a triangulation tower—is pictured in an accompanying illustration. Its location at Ashokan is doubly appropriate. This famous reservoir is an important part of the Catskill water system, to the development of which Mr. Smith gave many of the best years of his life. And nearby is "Menaltink," the country home where he delighted to entertain his friends.

The dedication ceremony includes addresses by George McAneny, John F. Galvin, and George J. Gillespie, and a program of songs followed by an informal gathering.

A tribute to Mr. Smith, published in CIVIL ENGINEERING at the time of his death, described him as "a man of quiet yet dynamic force, always looking to the future and anticipating the consequences of every decision and the results of every construction. His entire life was based on fairness, on justice, and on honesty."



A TRIBUTE TO A FAMOUS ENGINEER, "ERECTED BY HIS FRIENDS"
Dedicated June 25, 1936

A memoir of Mr. Smith is also being published by the Society. It contains not only the fascinating story of his thirty years of service to the City of New York, and a brief review of some of his engineering achievements, but a description, as well, of the personal attributes that won him the love and respect of those who worked with him and for him.

The memoir tells also of his persistent efforts to surmount the technical and legal difficulties in the way of augmenting New York's water supply with water from the Delaware River. It is interesting to note that only a few weeks ago the Board of Estimate of the City of New York authorized an appropriation of $17,500,000 to begin construction of this diversion.

Brief Notes from Here and There

THE International Association for Bridge and Structural Engineering will hold its Second International Congress October 1–8, 1936, in Berlin, Germany. Among the subjects to be considered are practical questions in connection with welded steel structures, recent points of view concerning the calculation and design of reinforced concrete structures, theory and research on details of welded and riveted steel structures, and research concerning building ground. The reports will be published in the three official languages—German, English, and French—and a special telephone installation will be provided, allowing the participants to follow the sessions in each of the three languages. Besides the technical and scientific work, there will be several excursions and visits to important structural works. Additional information can be obtained from the Secretariat of the International Association for Bridge and Structural Engineering, Swiss Federal Institute of Technology, Zurich, Switzerland.

* * * *

To celebrate his seventy-third birthday, on April 25, 1936, T. Kennard Thomson, M. Am. Soc. C.E., took a 19-mile walk from New York City to his home in Yonkers, N.Y. This feat recalls that of Frederick N. Willson, another Member of the Society, who on his eightieth birthday traversed the catwalk of the Golden Gate Bridge, between towers. This feat was referred to in the April issue. From such reports as these, civil engineers would seem to be a hardy, active group.

* * * *

THE Montana earthquakes of October 1935 brought home to the residents of a large area where it had previously been given little thought, the need for earthquake-resistant construction. Accordingly, the engineering experiment station

of Montana State College chose that subject for its first bulletin, which has been published as "State College Series No. 100." In order that it may be of value to city officials, school boards, and tradesmen as well as to engineers, the bulletin is made as non-technical as possible. The general theories of earthquake-proof design and the methods of construction are explained, and several pages of photographs of typical structural failures are included.

* * * *

The University of Alaska is instituting a five-year course in civil engineering. The first two years meet the general needs of all students who expect to follow any of the branches of engineering. At the conclusion of four years, a degree of bachelor of science may be obtained, and this course is said to provide "a thorough basic training along technical lines together with a liberal amount of non-technical work." The fifth year permits further specialization and a considerable opportunity for elective subjects, leading to the degree of bachelor of civil engineering. William E. Duckering, M. Am. Soc. C.E., is dean of the faculty and head of the department.

NEWS OF ENGINEERS

Personal Items About Society Members

Felix James Keaveny, formerly with Madigan and Hyland, of New York City, has taken a position as structural designer on the Panama Canal.

Thomas U. Taylor has just retired as dean of engineering at the University of Texas after forty-eight years of teaching.

John L. Nagle, assistant chief engineer of the eastern division of the National Park Service, is in charge of construction of the Thomas Jefferson memorial in St. Louis.

Andrew G. Bisset, lieutenant commander, C.E.C., U. S. Navy, has been transferred from Pearl Harbor, Hawaii, to duty at the U. S. Naval Academy at Annapolis, Md.

Edward P. Lupfer, consulting and contracting engineer of Buffalo, N.Y., has been appointed directing engineer of the Buffalo Sewer Authority.

Abel Wolman, chief engineer for the Maryland State Department of Health, has been appointed one of the delegates to represent the state at the Third World Power Conference, to be held in Washington, D.C., from September 7 to 12.

Harold M. Sylvester, lieutenant, C.E.C., U. S. Navy, formerly in the design division of the Bureau of Yards and Docks at Washington, D.C., has been made assistant public works officer at the naval air station at Anacostia, D.C.

A. F. Johnson, assistant engineer with the U. S. Bureau of Reclamation, has gone to the Virgin Islands where he will make a study of water resources to determine the amount of unused water available for municipal and irrigation purposes.

Alfred M. Lund is now chief engineer inspector for the Little Rock (Ark.) water supply system.

Roy E. Ramseier, formerly a draftsman with Alameda County (California) Mosquito Abatement, has received an appointment as sanitary engineer of Imperial County, California.

Joseph C. Harker is now a junior engineer in the design division of the Los Angeles office of the Metropolitan Water District of Southern California.

S. Boyd Downey, formerly chief draftsman for the M. A. Long Company, of Baltimore, Md., is now connected with the Pennsylvania Water and Power Company in the capacity of structural designer.

Francis Tingley has taken a position with Ford, Bacon and Davis, Inc., with headquarters in New York City.

James B. Hays is construction engineer for the Tennessee Valley Authority at Chickamauga Dam, Chattanooga, Tenn. Previously he was with the U. S. Bureau of Reclamation at Denver, Colo.

G. R. Harr, who was formerly engineer of specifications for the State Highway Commission of Indiana, has become an associate highway engineer with the U. S. Bureau of Public Roads. He is assigned as bureau manager of the Indiana State-Wide Highway Planning Survey.

Norman R. Gibson has been appointed a member of the New York State Board of Examiners for Professional Engineers to fill the vacancy created by the death of A. H. Hooker. Dr. Gibson, who is vice-president of the Buffalo, Niagara and Eastern Power Corporation, is the third civil engineer on the Board.

Carl H. Hoyem is assistant engineer for the Works Progress Administration at Minot, N.Dak.

James E. Czel has taken a position in the watershed and hydrologic studies division of the U. S. Soil Conservation Service, with headquarters in Coshocton, Ohio. He was formerly in the North Carolina State Highway Department.

Harlow M. Stafford, supervising hydraulic engineer with the California State Department of Public Works, is on leave of absence to assume charge of a water resources investigation of the Rio Grande River from Colorado to El Paso, Tex., which is being made by the U. S. Department of the Interior. His temporary headquarters are at Santa Fé, N.Mex.

Jerald E. Christiansen, formerly junior irrigation engineer for the University of California, is now assistant irrigation engineer.

J. R. Fenstermaker has accepted a position in the Decatur (Ill.) office of the Hugh J. Baker Company of Indianapolis, Ind. He was formerly with the State Highway Commission of Indiana.

A. S. Hadley has been made president of the Standard Bitulithic Company of New York City. Previously he was with Warren Brothers Company of Argentina at Buenos Aires.

E. M. Jenkins, formerly research engineer for the Johns-Manville Research Laboratories, at Manville, N.J., is now with Selective Residential Construction, Inc., at Mamaroneck, N.Y.

James A. Erskine has joined the staff of the State Highway Commission of Indiana in the capacity of assistant project engineer.

Walter A. Ortolani, who is with the State Highway Department of Texas, has been transferred to Carthage, Tex., where he is resident engineer for Panola County.

Henry M. Townsend has entered the employ of the Tennessee Valley Authority, being engaged in the field inspection of planimetric maps. Previously he was with the U. S. Geological Survey.

Elmer L. Foster, formerly with the State Highway Commission of Indiana, is now in the engineering department of the W. J. Holliday Company of Indianapolis, Ind.

John A. Norris is now chief engineer and general manager of the Brazos River Conservation and Reclamation District, with headquarters in Temple, Tex. Mr. Norris was formerly with the Texas State Board of Water Engineers.

William W. Carlton has established a consulting engineering practice at 4132 Davis Lane, Cincinnati, Ohio. Previously he was in the Cincinnati Department of Buildings.

Compere Loveless has become assistant project engineer on construction for the bridge department of the Indiana State Highway Commission. He is located at Princeton, Ind.

Alfred H. Renshaw, formerly vice-president of the General Railway Signal Company, of New York City, is now chairman of the board and director of this organization.

Alexander M. Vance, formerly engineer examiner for the Public Works Administration at Fort Worth, Tex., has been made resident engineer inspector for the same organization at Lubbock, Tex.

Samuel B. Morris has been appointed dean of the school of engineering at Stanford University to succeed Theodore J. Hoover who is retiring. Professor Morris, who was formerly chief engineer and general manager of the Pasadena Water Department, has been serving as executive head of the department of civil engineering during the past year.

G. DOUGLAS ANDREWS is now state director of the Pennsylvania Public Works Administration, with offices in Harrisburg, Pa.

ROY W. CARLSON has accepted a position in the civil engineering department of the Massachusetts Institute of Technology. Previously he was in the engineering materials laboratory of the University of California.

C. R. LOGAN, who was formerly employed as superintendent of Soil Conservation Camp 7 at Stockton, Ill., is now resident engineer inspector for the Public Works Administration at Lexington, Ky.

CARNIG KAY has resigned from the U. S. Department of Agriculture to become general construction inspector with the Metropolitan Water Supply Commission at Enfield, Mass.

AUGUST L. AHLF was recently promoted from the position of field clerk in the inspection division of the Public Works Administration to that of junior engineer in the same organization. This promotion transfers him from the state of Utah to Denver, Colo.

HARRY P. BURDEN, formerly professor of sanitary engineering at Tufts College, was recently appointed dean of the college of engineering there.

WILLIAM IRWIN is now assistant construction superintendent for the E. I. du Pont de Nemours and Company Dye Works at Penns Grove, N.J. Previously Mr. Irwin was supervising engineer for the U. S. Coast and Geodetic Survey, with headquarters in Philadelphia, Pa.

EDMUND L. DALEY, colonel, Corps of Engineers, U. S. Army, has been transferred from Fort Humphreys, Washington, D.C., to New York City, where he will serve as district engineer for the First New York District.

R. P. LEBARON, recently resigned as assistant welding engineer for the U. S. Bureau of Reclamation to become sales engineer for the Midwest Steel and Iron Works Company at Denver, Colo.

DECEASED

JOSEPH CHESTER ALLISON (M. '17) consulting engineer and president of the San Diego Municipal Warehousing Corporation, died in La Jolla, Calif., on May 29, 1936, at the age of 52. Mr. Allison was instrumental in the development of the water resources of San Diego. From 1902 to 1916 he was employed in various capacities by the California Development Company. In the latter year he established a consulting practice in Los Angeles and Calexico, Calif., later transferring his office to San Diego. Mr. Allison played an important part in the engineering activities which accomplished the upbuilding of the great inland valleys along the Colorado.

WILLIAM ANDERSON AYCRIGG (M. '98) consulting engineer of Stamford, Conn., died in that city on May 30, 1936. He was born in 1859 and graduated from Rensselaer Polytechnic Institute in 1884. In 1889, after some engineering experience in the West, Mr. Aycrigg joined the staff of the Edge Moor Bridge Works at Edge Moor, Del., where he remained for a number of years. Later he was bridge engineer for the Western Pacific Railway Company in San Francisco. About twenty years ago he established his consulting engineering practice in Stamford.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

STEPHEN ELDRIDGE COOMBS (M. '02) a retired civil and construction engineer of Yonkers, N.Y., died in New York City on May 22, 1936, at the age of 70. In 1887, upon his graduation from Massachusetts Institute of Technology, he became associated with Col. George Waring, Jr., of New York City. He then engaged in railroad engineering work in the West. In 1903 he joined the staff of the New York Central, remaining in the service of this road until his retirement in 1935. In 1926, he became special engineer at New York for the land and tax department of the railroad.

JOSEPH FIRTH (M. '25) engineer of materials and tests in the Philadelphia Bureau of Highways, died on May 10, 1936. Mr. Firth was born in Philadelphia, Pa., on October 16, 1878, and graduated from Rensselaer Polytechnic Institute in 1901. As city engineer of Charlotte, N.C. (from 1907 to 1914 and from 1920 to 1925), he was responsible for many municipal improvements. From 1915 to 1919 he was commissioner of public works at Winston-Salem, N.C. Mr. Firth taught for two years at Oklahoma Agricultural and Mechanical College. Since 1929 he had been with the Philadelphia Bureau of Highways.

FRANK FIFIELD HEALEY (Assoc. M. '20) died in Chicago, Ill., on May 21, 1936. He was born in Hingham, Mass., in 1869 and was educated at Stevens Institute of Technology. In 1907 he became engineer in charge of the Chicago underground freight tunnel, bridges, and terminals. From 1910 to 1918 Mr. Healey was in general construction work, and in 1918 he was appointed a major in the construction division of the U. S. Army. After the War he became a general construction superintendent and in 1924 a member of the contracting firm of Hansen and Healey. In 1926 he became appraisal engineer for the State Bank of Chicago, remaining there until his retirement in 1931.

CHARLES ROYDEN HOYT (M. '34) structural engineer for the Los Angeles Board of Education, died in March 1936, at the age of 37. Mr. Hoyt was born in Philadelphia, Pa., and graduated from Pennsylvania Military College in 1917. A specialist in the design of bridges and buildings, Mr. Hoyt had been structural engineer with several Chicago and New York firms. From 1923 to 1930 he was in charge of the design and construction of all structures for the South Park Commission of Chicago. In 1935 he joined the staff of the Los Angeles Board of Education.

GEORGE CASPER DOERING LENTH (M. '12) for the past fifteen years consulting engineer and secretary of the Clay Products Association, Chicago, Ill., died there on May 11, 1936. Mr. Lenth was born in Garrett, Ind., in 1882 and graduated from the Massachusetts Institute of Technology in 1903. His early engineering experience was in telephone, bridge, and sewer work for Chicago and Cook County. From 1911 to 1921 he was assistant chief engineer of the Chicago Board of Local Improvements. In 1930 and 1931 he served as a member of the Chicago Advisory Subway Engineering Commission.

EARL STIMSON (M. '20) chief engineer of maintenance for the Baltimore and Ohio Railroad, died on May 27, 1936, at Massillon, Ohio. He was 63. Mr. Stimson was born in Cincinnati, Ohio, and educated at the University of Cincinnati and Cornell University. In 1895 he joined the staff of the Baltimore and Ohio Railroad, and his entire career was spent with this organization and its affiliated lines. For many years he was active in the affairs of the American Railway Engineering Association, serving as its president for one term. Mr. Stimson was the author of numerous articles that appeared in railway journals.

HOWARD EDWARD VAN NESS (Assoc. M. '07) construction engineer for the Central Railroad of New Jersey, Plainfield, N.J., died in 1935. Mr. Van Ness was born in Newark, N.J., in 1875, and graduated from Rutgers University in 1896. In 1902, after early experience as a draftsman and transitman, he became connected with the Central Railroad of New Jersey. In the course of his long connection with this organization he was in charge of construction of the Newark Bay rolling-lift bridge, the Elizabethport freight piers, the Jersey City terminal, and other projects.

RAY BENEDICT WEST (M. '28) dean of engineering and mechanic arts at the Utah State Agricultural College since 1916, died at Logan, Utah, on June 3, 1936, at the age of 53. He was born at Ogden, Utah, and was educated at the Utah State Agricultural College and Cornell University. In 1912, after several years of teaching and railroad work, he joined the staff of the Utah State Agricultural College. Dean West supervised the design and construction of numerous college buildings. During the past year

he had been on leave of absence from the college in order to serve as director of the state planning board.

ARTHUR CHAMBERS WHEELER (M. '26) resident engineer of the Territorial Highway Department, Honolulu, T. H., died on June 3, 1935, at the age of 54. He was born in Detroit, Mich., and graduated from the University of Michigan in 1903. From 1905 to 1908 Mr. Wheeler was engaged on private engineering projects in the Philippines. For the next three years he was with the U. S. Corps of Engineers in Hawaii. Later he was connected with the Honolulu Department of Public Works, was county engineer of Hawaii County in charge of all public works, and finally became resident engineer of the Territorial Highway Department.

FRANK ORMOND WHITNEY (M. '87) of Boston, Mass., died at his home in that city on May 13, 1936, at the age of 84. He was born in Fitchburg, Mass., and graduated from Worcester Polytechnic Institute in 1871. In the same year Mr. Whitney entered the engineering department of the City of Boston, where he remained for over fifty years, retiring in 1924. For many years he was in charge of all street construction in that city.

AARON STANTON ZINN (M. '09) a civil engineer of South Bend, Ind., died there on May 7, 1936. Mr. Zinn was born in Logansport, Ind., on August 26, 1866, and was educated at Rose Polytechnic Institute. A specialist in the field of railroad, canal, and harbor work, he was resident engineer in charge of various construction work on the Panama Canal from 1906 to 1914. For the next three years he was consulting engineer for the Republic of Panama. In 1923 he began work with the city and county of Los Angeles, being chief draftsman of the preparation of harbor plans and draftsman on sewer plans. Illness forced his retirement a few months ago. Mr. Zinn was the author of numerous articles in technical periodicals.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From May 10 to June 9, 1936, Inclusive

ADDITIONS TO MEMBERSHIP

ALBRECHT, ERICH WOLFGANG (Assoc. M. '32), 202 East Seaman Ave., Freeport, N.Y.

BATCHELDER, CHARLES LELAND (M. '36), Dist. Engr., U. S. Geological Survey, 808 New Post Office Bldg., St. Paul, Minn.

BLANK ROTH, CÉSAR AUGUSTO (Jun. '35), With Caribbean Petroleum Co.; Este 13, No. 30, Caracas, Venezuela.

BROWN, DWIGHT (Asoc. M. '36), Project Engr., State Road Dept., Haines City, Fla.

CAMBERN, THEODORE JESSUP (Assoc. M. '36), Asst. Engr., Harrington & Cortelyou (Res., 4829 Holly St.), Kansas City, Mo.

CARTELLI, ANTHONY RAYMOND (Jun. '36), Rodman, WPA, Dept. of Parks (Res., 173 East 165th St.), New York, N.Y.

CERNY, PAUL JOSEPH (Assoc. M. '35), Care, Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

CHAPTON, HERBERT JOSEPH (Jun. '36), Senior Topographical Draftsman, Bureau of Water Works and Supply, City of Los Angeles, Los Angeles (Res., 727 North Jackson St., Glendale), Calif.

COCKEY, JOHN DAVIDSON (Assoc. M. '36), Prin. Eng.-Insp. Supt., U. S. Bureau of Public Roads, Roanoke, Va. (Res., Claiborne, Md.)

CORUM, WILLIAM THOMAS (Jun. '36), Junior Administrative Asst., Regional Office, Dept. of Operations, Branch of Impvts., U. S. Dept. of Agriculture, Forest Service, 200 South 12th St., Richmond, Calif.

DAVIS, CHESTER ARTHUR (Jun. '35), Transitman, Surveying Dept., Pacific Elec. Co., Los Angeles (Res., 226 South 3d St., Alhambra), Calif.

DAVIS, GRANT LIVINGSTON (Jun. '35), Pittsburg, N.H.

DAY, GORDON (Jun. '36), 100 East Palisade Ave., Englewood, N.J.

DEMLER, LESTER ERNEST (Jun. '35), Care, Wallace & Tiernan Co., Inc., Newark, N.J.

DONA, DOMENIC AMERIGO (Jun. '35), Clerk, Bank of America (Res., 2547 Johnston St.), Los Angeles, Calif.

ENGLER, LESLIE WINFRED (Jun. '36), Tutor, Civ. Eng. Dept., Coll. of the City of New York (Res., 522 West 136th St., Apartment 2B), New York, N.Y.

FISCHER, ANTHONY JOSEPH (Assoc. M. '36), San. Development Engr., The Dorr Co., Inc., 247 Park Ave., New York, N.Y.

FLETCHER, FRANK (Jun. '35), 53 Harcourt Ave., Pawtucket, R.I.

GOODWIN, JAMES WILLIAM (Assoc. M. '36), Cons. Engr. (J. W. Goodwin Eng. Co.), 1241 Martin Bldg., Birmingham, Ala.

HALL, LOUIS WOODROW (Jun. '35), Bldg. 233, Naval Air Station, Pensacola, Fla.

HANLEY, THOMAS JOSEPH (Jun. '35), 255 East 207th St., New York, N.Y.

HEFELFINGER, CHARLES MOSES (Jun. '35), Field Engr., Linus R. Gilbert Inc., Union Bldg., Plainfield, N.J. (Res., 1202 South 10th St., Allentown, Pa.)

HILL, GORDON TRAVIS (Jun. '35), Box 1023, Bryan, Tex.

HIZON Y OCHOA, ANDRES (Jun. '36), 3106 Eighteenth St., N. W., Washington, D.C.

HUGHES, CHARLES EDOUARD, JR. (Jun. '35), 1611 Camp Ave., Rockford, Ill.

IVORY, WILLIAM EDWARD (Jun. '35), Draftsman, Norwich Pharmacal Co. (Res., 25 Division St.), Norwich, N.Y.

TOTAL MEMBERSHIP AS OF JUNE 9, 1936	
Members	5,710
Associate Members	6,215
Corporate Members	11,925
Honorary Members	19
Juniors	3,235
Affiliates	94
Fellows	1
Total	15,274

JIMMERSON, DAVID CHARLES (Assoc. M. '35), Associate Highway Engr., U. S. Bureau of Public Roads, Box 60, Montgomery, Ala.

JOHNSON, CHARLES ALBIN, JR. (Jun. '36), Marine Draftsman, Navy Yard, Brooklyn, N.Y.

JOHNSTONE, WILLIAM JARL (Jun. '35), 747 West 7th St., Reno, Nev.

JOSEPH, LOUIS WYMAN (Assoc. M. '35), Asst. Engr., Gibbs & Hill, Pennsylvania Station, New York (Res., 42-46 Two Hundred and Forty-Eighth St., Little Neck), N.Y.

KRUSA, PAUL HENRY (Jun. '35), With Great Lakes Constr. Co., 5824 Cates, St. Louis, Mo.

LAFOLLETTE, ROBERT MEREDITH (Jun. '36), Care, Currie Eng. Co., Webster City, Iowa.

LAUKAITIS, GEORGE EDWARD (Jun. '35), 59-56 Fifty-Seventh Rd., Maspeth, N.Y.

LAURGAARD, GLENN OLAF (Jun. '36), Laboratory Asst., U. S. Bureau of Reclamation, Box 704, Yuma, Ariz.

LEMCKE, KARL WOLFGANG (Assoc. M. '36), Designer and Detailer, N.Y.C.R.R., 466 Lexington Ave., New York (Res., 67 Chestnut St., Flushing), N.Y.

MACNAUGHTON, GEORGE DOUGLAS (Assoc. M. '36), Chf. of Party, Plans and Surveys, State Highway Dept., Union (Res., 94 South Munn Ave., East Orange), N.J.

MCLEAN, WILLIAM BISSEL (Assoc. M. '36), Designer, Fabricated Steel Constr., Bethlehem Steel Co. (Res., 1613 Cloverleaf St.), Bethlehem, Pa.

MILLER, ARTHUR PATTERSON (M. '36), San. Engr., U. S. Public Health Service, Sub-Treasury Bldg., Pine and Wall Sts., New York, N.Y.

MILLER, EUGENE CLAIR (Jun. '35), Box 336, Glendora, Calif.

MILLER, JOHN HENRY, JR. (Assoc. M. '36), Pres., J. Henry Miller, Inc., Eutaw and Franklin Sts., Baltimore, Md.

MINSHALL, NEAL EDWARD (Assoc. M. '36), Eng. Supervisor, ECW Camps, SCS (Res., 326 North 7th St.), La Crosse, Wis.

NICHOLS, PAUL LEWIS (Jun. '35), Draftsman,

Bridge Dept., State Highway Dept., Box 419, Carson City, Nev.

PALMORE, HOVEY DUNCAN (M. '36), Pres. and Gen. Mgr., Kentucky Concrete Pipe Co., Inc. (Res., 812 Shelby St.), Frankfort, Ky.

PARKER, WALTER HUNTINGTON (M. '36), Prof. and Head of Dept. of Min., School of Mines and Metallurgy, Univ. of Minnesota (Res., 5101 South Sheridan Ave.), Minneapolis, Minn.

PFLUCKER, WILFREDO DE AZPILCUETA (Jun. '35), Research Engr., International Petroleum Co., Talara, Peru.

PINKERTON, RICHARD DAVID (Jun. '36), Instrumentman, Pacific Elec. Ry. Co., Los Angeles (Res., 1517 East Central Ave., Balboa), Calif.

PRATT, WILLIS GROVER (Jun. '35), Care, State Highway Comm., Bridge Div., Augusta, Me.

RAWSTROM, FREDERICK JOSEPH (Jun. '35), Draftsman, Central of Georgia R. R., 211 East 55th St., Savannah, Ga.

REED, REX RAYMOND (Jun. '36), Junior Engr., U. S. Bureau of Reclamation (Res., 3086 West 34th Ave.), Denver, Colo.

REIFF, JOHN ROBERT (Jun. '36), Asst. Engr., U. S. Engrs., Pittock Blk. (Res., 2208 North East Multnomah St.), Portland, Ore.

ROTH, ARTHUR THEODORE (Jun. '36), Junior Agri. Engr., U. S. Dept. of Agriculture, SCS, 420 Oak St., Indiana, Pa.

SAUER, VICTOR WOODROW (Jun. '35), Room 701, City Hall, Oakland, Calif.

SCHAPIRO, KOPPEL (Assoc. M. '36), Designer, Harza Eng. Co. (Res., 2614 Nineteenth St.), Columbus, Nebr.

SCHOOLEY, FLOYD WAYNE (Assoc. M. '36), With Chicago Bridge & Iron Works (Res., 325 South Small Drive), Los Angeles, Calif.

SERRA-ZANETTI, UGO (Assoc. M. '36), Designer, U. S. Navy Yard Brooklyn (Res., 344 West 45th St., New York), N.Y.

SHAFER, IRA ROY (Jun. '35), 30 East Halley St., Mount Union, Pa.

SHAVER, ROBERT EZEKIEL (Assoc. M. '36), Asst. Prof., Civ. Eng., Univ. of Kentucky, Lexington, Ky.

TAYLOR, THOMAS FREDERIC (Assoc. M. '36), Field Engr., TVA, Chickamauga Dam, Chattanooga, Tenn.

THOMPSON, GEORGE ALTON (Assoc. M. '36), Designer, Engr., New York Terminal Dist., N.Y. C.R.R., 466 Lexington Ave., Room 953, New York, N.Y.

THURING, ADOLPH CARL (Jun. '36), Junior Engr., U. S. Engr. Dept. (Res., 523 Cheyenne St.), Fort Peck, Mont.

TOUREK, JAMES CHARLES (Jun. '35), 5743 West 23d Pl., Cicero, Ill.

TREADWELL, WILLIAM FRANK (Jun. '35), 3607 Bainbridge Ave., New York, N.Y.

WHITTAKER, JOHN DEAN (Jun. '36), Surveyor, Windpass Gold Min. Co., Ltd., Boulder, B.C., Canada.

WILSON, VERNE GEORGE (Jun. '36), Draftsman, State Highway Comm. (Res., 218 Ash Ave.), Ames, Iowa.

MEMBERSHIP TRANSFERS

BANDY, WILLIAM ROY (Assoc. M. '20; M. '36), U. S. Cadastral Engr., Gen. Land Office, Box 1711, Helena, Mont.

BAROFSKY, MAX (Assoc. M. '27; M. '36), Dist. Engr., Bridge and Sewer Div., Bureau of Highways, City of Philadelphia (Res., 7016 Old York Rd.), Philadelphia, Pa.

BELLAMY, EARL DELAINE (Jun. '29; Assoc. M. '36), Asst. Engr. Harris County (Res., 3419 Burlington Ave.), Houston, Tex.

BERGMAN, ELMER OTTO (Assoc. M. '29; M. '36), Associate Prof., Civ. Eng., Univ. of Colorado, Boulder, Colo.

DORT, JOSEPH CUMMINGS (Assoc. M. '15; M. '36), Asst. Regional Forester, Div. of Eng., U. S. Forest Service, 724 Ninth St., N.W., Washington, D.C.

DRESSER, GEORGE LUCAS (Assoc. M. '17; M. '36), Vice-Pres. and Treas., The Standard Eng. Corporation; Pres., The Wertz Co.; Bridge Engr. and Eastern Railroad Representative, The Jennison-Wright Co., 444 Broadway, Room 405, Albany, N.Y.

EGBERT, DONALD CARLYLE (Jun. '30; Assoc. M. '36), County Supervisor; City Assessor and Building Insp., City of Birmingham, Municipal Bldg., Birmingham, Mich.

ETTINGER, LOUIS JOSEPH, JR. (Jun. '33; Assoc. M. '36), Chf. Engr., Eastern Road Dept., International Salt Co., Scranton, Pa. (Res., Elizabeth St., Skaneateles, N.Y.)

EVANS, SAMUEL ANTHONY (Assoc. M. '33; M. '36), Structural Designer, Dept. of Water and Power, City of Los Angeles, 207 South Broadway (Res., 1438 North Coronado St.), Los Angeles, Calif.

FRICKE, FREDERICK JOHN (Jun. '29; Assoc. M. '36), Prin. Eng. Draftsman, TVA, Daylight Bldg., Knoxville, Tenn.

FUNK, LOUIS (Jun. '31; Assoc. M. '36), Asst. Engr., Park Dept., City of New York (Res., 1114 Gerard Ave.), New York, N.Y.

GOLDBERGER, HAROLD WILLIAM (Jun. '32; Assoc. M. '36), Constr. Engr., Cornell Contr. Corporation, Chrysler Bldg., New York (Res., 2540 Thirtieth Rd., Astoria), N.Y.

GRANACHER, CHARLES WILLARD (Jun. '29; Assoc. M. '36), Field Engr., Dravo Contr. Co. (Res., 12 State St.), Gallipolis, Ohio.

HAZARD, STUART GRAY (Jun. '28; Assoc. M. '36), Cons. Engr., Associated with R. A. Finney, 626 New England Bldg. (Res., 115 Quinton Ave.), Topeka, Kans.

HENNING, CHARLES SUMNER, JR. (Jun. '13; Assoc. M. '15; M. '36), Vice-Pres. and Gen. Mgr., Womack-Henning Constr. Co., Abilene, Tex.

HOBART, THOMAS FITZHUGH (Jun. '28; Assoc. M. '36), Res. Engr., State Highway Dept., Box 295, Carrollton, Ala.

INGRAM, TEMPLE BYRN (Jun. '29; Assoc. M. '36), Res. Engr., Lamb County, State Highway Dept., Box 357, Olton, Tex.

KELLY, THOMAS ALFRED, JR. (Jun. '30; Assoc. M. '35), Prof., Civ. Eng., Colorado School of Mines (Res., 1592 Maple St.), Golden, Colo.

KING, HOWARD LANGDON (Jun. '17; Assoc. M. '20; M. '36), Chf. Engr., Mason & Hanger Co., Inc., 451 Eleventh Ave., New York, N.Y.

KOHLER, MERVIN HOWARD (Assoc. M. '30; M. '36), Asst. Engr., Bureau of Eng., Surveys and Zoning, Room 1214, City Hall Annex (Res., 960 Wagner Ave.), Philadelphia, Pa.

MICHAELS, ERNEST EDWIN (Assoc. M. '26; M. '36), Plant Mgr., Chicago Bridge & Iron Works, Drawer C, Woodlawn Station, Birmingham, Ala.

MITCHELL, THOMAS JOSEPH (Assoc. M. '27; M. '36), Asst. Geodetic Engr., U. S. Coast and Geodetic Survey, Commerce Bldg., Washington, D.C.

MUNDT, KENNETH FRANCIS (Jun. '30; Assoc. M. '35), Civ. Engr., Standard Oil Co. of California (Res., 4232 Fulton St.), San Francisco, Calif.

NETTLETON, DOUGLAS ARTHUR (Jun. '26; Assoc. M. '36), Designer, The Port of New York Authority, New York, N.Y. (Res., 159 South Clinton St., East Orange, N.J.)

OSGOOD, WILLIAM R. (Assoc. M. '25; M. '36), Materials Testing Engr., National Bureau of Standards (Res., 3633 Ingomar Pl., N.W.), Washington, D.C.

PREGLER, ANTON ANDREW (Assoc. M. '24; M. '36), Structural Engr., PWA, Housing Div., 21st St. and C St., N.W. (Res., 712 Marietta Pl., N.W.), Washington, D.C.

PROFFITT, GORDON HARRISON (Jun. '29; Assoc. M. '36), Special Agt.-Engr. Grade, Div. of Investigations, PWA; 2427 Hilgard Ave., Berkeley, Calif.

SAMPSON, RAPHAEL (Jun. '30; Assoc. M. '36), Associate Bridge Designing Engr., San Francisco–Oakland Bay Bridge, 500 Sansome St. (Res., 1810 Jackson St.), San Francisco, Calif.

SCHROEPFER, GEORGE JOHN (Jun. '30; Assoc. M. '36), Asst. Chf. Engr., Minneapolis-St. Paul San. Dist., 1923 University Ave., St. Paul (Res., 4715 Nokomis Ave., Minneapolis), Minn.

SEDGWICK, GEORGE ARTHUR (Jun. '27; Assoc. M. '36), Asst. Bridge Designing Engr., Div. of Highways, State Dept. of Public Works (Res., 3951 D St.), Sacramento, Calif.

STEVENSON, HOMER EADS MACGREGOR (Jun. '27; Assoc. M. '36), Res. Engr., State Highway Dept., Box 337, Llano, Tex.

TORREY, GEORGE ARMSTRONG (Jun. '29; Assoc. M. '36), Signal Draftsman, Interborough Rapid Transit Co., New York (Res., 239 Park Hill Ave., Yonkers), N.Y.

WADDELL, FREDERICK CREELMAN (Assoc. M. '05; M. '36), Superv. Engr., New Jersey Local Control Survey, 19 Whittlesey Ave., East Orange, N.J.

WARLOW, EARNEST JUDSON (Jun. '30; Assoc. M. '36), Asst. Structural Engr., Procurement Div., Treasury Dept. (Res., 1814 N St., N.W.), Washington, D.C.

WOLFE, JOSEPH MARION (Jun. '26; Assoc. M. '35), Draftsman-Computor, TVA, Wilson Dam, Ala.

REINSTATEMENTS

BOLAFFIO, ROBERT, Assoc. M., reinstated Apr. 20, 1936.

ESCOTO, CARLOS JOSE, Assoc. M., reinstated June 1, 1936.

KELLY, THOMAS JAMES, Assoc. M., reinstated June 8, 1936.

RESIGNATIONS

ALLEN, HAROLD JOSEPH, Assoc. M., resigned May 12, 1936.

COOMBS, THOMAS, M., resigned May 26, 1936.

DICKINSON, JOSEPH HAINES, M., resigned May 26, 1936.

FITZGERALD, WALTER FRANCIS ANTHONY, Jun., resigned May 26, 1936.

MITCHELL, HARRINGTON CALKINS, Jun., resigned May 12, 1936.

MOORE, STUART BREATHED, M., resigned May 25, 1936.

RUGGLES, CHARLES HERMAN, M., resigned May 12, 1936.

SIMONDS, FRED WASHBURN, M., resigned May 26, 1936.

WHITE, DAVID EWING, Assoc. M., resigned May 26, 1936.

WHITE, HARRY LIVELY, JR., Assoc. M., resigned May 26, 1936.

WILSON, WILLIAM SIDNEY, Assoc. M., resigned May 18, 1936.

WRIGHT, EVERETT GARDINER, Assoc. M., resigned May 26, 1936.

ZELIFF, DAVID WILLIAM, Assoc. M., resigned May 26, 1936.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

July 1, 1936 — NUMBER 7

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years †	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

AHRANO, FREDERICK WILLIAM, Pensacola, Fla. (Age 23.) Project Engr., Florida WPA, Dist. 9. Refers to T. M. Lowe, P. L. Reed, W. L. Sawyer.

ALGERT, HENRY WELLS, Roosevelt, Ariz. (Age 31.) Asst. Engr., Salt River Project, U. S. Bureau of Reclamation. Refers to R. G. Baker, J. A. Fraps, F. C. Kelton, W. W. Lane, R. V. Leeson, J. W. Powers, J. G. Tripp.

BALURDO, FRANK, JR., New York City. (Age 33.) Eng. Constructor and member of firm, Mayfair Contr. Co. Refers to B. J. Ahearn, M. Alperin, H. Holbrook, J. B. Martin, A. N. Mulholland.

BANKS, HARRY ROSEBOOM, Watsonville, Calif. (Age 52.) Asst. Res. Engr. Inspector, PWA. Refers to E. F. Berry, O. E. Carr, M. M. Lewis, L. B. Reynolds, S. D. Sarason.

BARR, ALBERT STEPHEN, JR., Pittsburgh, Pa. (Age 22.) Refers to A. Diefendorf, L. C. McCandliss.

BAYLES, CHARLES CLIFFORD, McMinnville, Ore. (Age 24.) Oregon State Highway Office. Refers to J. R. Griffith, G. W. Holcomb, F. Merryfield, C. A. Mockmore.

BEAN, SHERMAN HUNN, Bound Brook, N.J. (Age 25.) Refers to N. D. Morgan, C. E. Palmer.

BEAR, HERBERT STANLEY, Great Lakes, Ill. (Age 44.) Lieut. Commdr., C.E.C., U. S. Navy; Public Works Officer. Refers to R. E. Bakenhus, G. S. Burrell, F. H. Cooke, C. T. Morris, A. L. Parsons, C. E. Sherman, R. M. Warfield.

BELSTERLING, RICHARD GORDON, Peoria, Ill. (Age 23.) Refers to N. D. Morgan, C. E. Palmer.

BLACK, WINSTON EDWARD, Chicago, Ill. (Age 20.) Refers to J. J. Doland, W. C. Huntington.

BRENNAN, Arthur, Rapid City, S.Dak. (Age 22.) Refers to A. A. Chenoweth, E. D. Dake.

BUCK, JOHN ELMER, Beardstown, Ill. (Age 23.) Refers to J. S. Crandell, T. C. Shedd.

BUMBY, ARTHUR STANLEY, West Palm Beach, Fla. (Age 21.) Refers to T. M. Lowe, P. L. Reed, W. L. Sawyer.

BYERS, CHARLES THOMAS, San Francisco, Calif. (Age 22.) Rodman and Chainman, Pacific Gas & Elec. Co. Refers to B. A. Etcheverry, C. G. Hyde, B. Jameyson, C. T. Wiskocil.

BYRNS, FORREST EUGENE, Quoddy, Maine. (Age 32.) Associate Engr., U. S. Engr. Office, War Dept., Eastport, Maine. Refers to J. E. Allen, H. J. Casey, S. L. Kerr, P. F. Kruse, G. R. Rich, J. Sweeney, R. C. Vogt.

CAESAR, GEORGE PHILIP ENGLER, JR., Milwaukee, Wis. (Age 20.) Refers to C. A. Ellis, H. S. Morse, R. B. Wiley.

CAPP, CRAIG THOMAS, Ames, Iowa. (Age 26.) Draftsman, Bridge Design Dept., Iowa Highway Comm. Refers to R. A. Caughey, A. H. Fuller, W. E. Galligan, F. Kerekes, J. R. Maher, Sr., R. A. Moyer.

CARDOINE, FRANCIS ANTHONY, Washington, D.C. (Age 25.) Jun. Topographic Engr., U. S. Geological Survey. Refers to J. B. Babcock, 3d, H. K. Barrows, R. W. Berry, J. G. Staack, R. M. Wilson.

CARNEY, LEONARD CLEMENT, Columbia, Mo. (Age 25.) Refers to R. B. B. Moorman, H. K. Rubey.

CLARK, ROY ROSS, Portland, Ore. (Age 49.) Designing Engr., U. S. Engr. Dept., Bonneville Dam Project. Refers to J. W. Cunningham, C. I. Grimm, L. Griswold, J. H. Lewis, C. H. Purcell, J. C. Stevens.

COHEN, HYMAN ISAAC, Bronx, N.Y. (Age 25.) Refers to R. C. Brumfield, F. E. Foss, M. H. Van Buren.

COOK, AULEY ALMERIN, Hammond, Ind. (Age 51.) Refers to R. L. Alexander, J. B. Cameron, E. R. Conant, C. J. Eldridge, F. B. Forbes.

COOKMAN, WILLARD GEORGE MINTER, Anderson, Ind. (Age 29.) Refers to C. A. Ellis, R. B. Wiley.

COYM, WILFRED, Corpus Christi, Tex. (Age 27.) Culvert Inspector and Plant Inspector, Texas State Highway Dept. Refers to T. W. Bailey, H. C. Hughes, M. Johnson, F. B. Mason, W. J. Van London.

CROMER, ORLAND DWIGHT, New Holland, N.C. (Age 26.) Jun. Civ. Engr., U. S. Biological Survey. Refers to W. E. Hall, R. C. Johnson, W. E. Rowe, R. L. Sumwalt, W. A. Vaught.

CROSS, OSCAR REEVES, Jr., Berkeley, Calif. (Age 25.) Refers to C. Derleth, Jr., C. T. Wiskocil.

CRUDEN, RAYMOND NICHOLAS, Fargo, N.Dak. (Age 25.) Refers to H. M. Fitch, W. E. Smith.

DAMITZ, KENNETH, Mt. Vernon, Ill. (Age 25.) Refers to J. J. Doland, W. C. Huntington, T. C. Shedd.

DEAKYNE, ELWOOD STAATS, Greensboro, Md. (Age 39.) Res. Engr. Inspector, FEA of PW. Refers to W. B. Catchings, E. W. Clark, C. N. Conner, J. F. Remley, C. P. Schantz, A. R. Wilson.

DEGENKOLB, HENRY JOHN, Berkeley, Calif. (Age 23.) Refers to R. E. Davis, C. T. Wiskocil.

de LANCEY, RAYMOND WINTHROP, Estacada, Ore. (Age 21.) Inspector, Oregon State Highway Comm. Refers to J. R. Griffith, F. Merryfield, C. A. Mockmore.

DEMENT, JAMES WASHINGTON, Jr., Vicksburg, Miss. (Age 27.) Jun. Engr., U. S. Waterways Experiment Station. Refers to G. R. Clemens, D. M. McCain, H. A. Sargent, C. P. Wright.

DE WITT, LYLE VINSON, Green City, Mo. (Age 21.) Refers to H. Cross, J. J. Doland, W. C. Huntington, N. D. Morgan, C. E. Palmer.

DIPPOLD, DANIEL STUBBS, Edwardsville, Ill. (Age 22.) Refers to J. S. Crandell, F. W. Stubbs.

DOGGETT, DENZIL, Indianapolis, Ind. (Age 41.) Asst. State Engr., Indiana Dept. of Conservation, Div. of Eng. Refers to H. O. Garman, W. K. Hatt, F. Kellam, W. A. Knapp, L. V. Sheridan, J. W. Wheeler, R. B. Wiley.

DORNER, WILLIAM JOHN, Portland, Ore. (Age 27.) Refers to F. Merryfield, C. A. Mockmore.

DOWLING, LOUIS EARL, Jr., Pittsburgh, Pa. (Age 27.) Designer with Jones & Laughlin Steel Corporation. Refers to F. J. Evans, C. D. Foight, F. M. McCullough, C. B. Stanton, H. A. Thomas, E. B. Woodin.

DRIESSEN, ROBERT EDWARD ERIC, Kaukauna, Wis. (Age 23.) Refers to C. A. Ellis, W. E. Howland, R. B. Wiley.

DULLY, HOWARD FRANKLIN, Portland, Ore. (Age 21.) Refers to F. Merryfield, C. A. Mockmore.

DUNNING, WILLIAM ALFRED, Los Angeles, Calif. (Age 37.) With Los Angeles County Flood Control Dist. Refers to E. C. Eaton, F. H. Hay, H. E. Hedger, C. H. Howell, A. S. Kemman, M. E. Salsbury.

DUNTON, ALLEN HENRY, Iowa City, Iowa. (Age 20.) Refers to B. J. Lambert, F. T. Mavis.

DUVALL, PHILIP KIRK, Logan, Iowa. (Age 34.) Member of firm, Duvall & McKinney. Refers to C. C. Coykendall, O. W. Crowley, J. S. Dodds, E. W. Dunn, A. W. Gaines, F. H. Mann, L. M. Martin, K. B. Merrill, J. E. Van Liew, E. Welden, G. F. Wickes, H. C. Wickes.

EITELBERG, SIDNEY, Brooklyn, N.Y. (Age 24.) Refers to F. E. Foss, G. Morrison, M. H. Van Buren.

ELLIOTT, ARCHER THOMAS, Evanston, Ill. (Age 23.) Refers to J. J. Doland, T. C. Shedd.

ELSENHANS, GEORGE EDWARD, Springfield, Mass. (Age 24.) Adams & Ruxton Constr. Co. Refers to F. W. Garran, W. P. Kimball.

ESTABROOK, JOSEPH BENEDICT, Minneapolis, Minn. (Age 46.) Office Engr. and in charge of Civ. Eng. Dept., Pillsbury Eng. Co. Refers to O. E. Brownell, G. E. Loughland, D. I. Okes, C. L. Pillsbury, M. Pirnie, R. R. Schweitzer.

EVANS, JOHN JOSEPH, Worcester, Mass. (Age 22.) Refers to G. J. Davis, Jr., J. S. Leister.

FRAGAN, WILBUR, Collinsville, Ill. (Age 22.) Refers to H. E. Babbitt, J. J. Doland, W. C. Huntington, T. C. Shedd, F. W. Stubbs.

FINNILA, ALFRED AUGUST, San Francisco, Calif. (Age 22.) Refers to B. A. Etcheverry, B. Jameyson.

FITCH, GILBERT ARTHUR, Oakland, Calif. (Age 22.) Refers to G. E. Troxell, C. T. Wiskocil.

FORREST, KYLE, Mineola, N.Y. (Age 30.) Hydrological Investigator, Nassau County, Long Island. Refers to C. L. Bogert, C. C. Chambers, A. W. Harrington, C. H. Hurley, T. R. Lawson, J. F. Sanborn, E. H. Sargent, B. M. Stark, W. F. Starks, R. Suter, L. B. Westfall.

FRANK, HERBERT LOUIS, San Francisco, Calif. (Age 21.) Refers to H. E. Babbitt, W. A. Oliver, R. Rasmussen.

FRESEN, MARTIN HENRY, Denver, Colo. (Age 36.) Associate Engr., U. S. Bureau of Reclamation. Refers to W. T. Collings, Jr., E. S. Randolph, J. L. Savage, B. W. Steele, A. R. Webb, I. A. Winter, J. Wright.

GERHART, JOHN WALLACE, Berkeley, Calif. (Age 21.) Refers to R. E. Davis, C. T. Wiskocil.

GIBBONS, JAMES EDWARD, New York City. (Age 51.) Cons. Engr. Refers to C. L. Bogert, J. C. Meem, E. P. Palmer, E. A. Prentis, R. Ridgway, J. F. Sanborn, L. White, H. D. Winsor.

GINESIN, SAMUEL, Brooklyn, N.Y. (Age 23.) Refers to G. Morrison, M. H. Van Buren, J. P. J. Williams.

GOSLINE, GEORGE WILLIAMS, Watsonville, Calif. (Age 32.) Dist. Engr., U. S. Dept. of Agriculture, Soil Conservation Service, in northern California. Refers to R. A. Floyd, R. E. Fowle, V. M. Freeman, R. H. Jamison, C. W. Petit, H. E. Reddick.

GREEN, ROBERT SMITH, Muncie, Ind. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

GREENBERG, JACK, Detroit, Mich. (Age 36.) Senior Structural Draftsman, City of Detroit. Refers to R. J. Cummins, L. M. Gram, M. C. Halsey, M. J. Quinn, R. J. Reed, I. C. Steele, E. G. Willemin.

HAND, ROBERT DAVID, Park Ridge, Ill. (Age 22.) Rodman, Wabash Ry. Refers to C. A. Ellis, R. B. Wiley.

HARP, GEORGE HAROLD, New York City. (Age 44.) Res. Engr. Inspector, U. S. Govt., PWA, Midtown Hudson Tunnel, New Jersey side. Refers to J. W. Daly, W. M. Griffin, H. P. R. Jacobsen, R. Ridgeway L. E. Robbe, J. B. Snow.

HARRIS, ERNEST RICHARD, JR., Denver, Colo. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

HATCH, GEORGE EDWIN, Wessington Springs S.Dak. (Age 22.) Refers to A. A. Chenoweth E. D. Dake.

HEIDENREICH, ROBERT MONROE, San Francisco, Calif. (Age 21.) Refers to C. G. Hyde, C. T. Wiskocil.

HENDRICKSEN, WILLIAM EDWARD, Chicago, Ill. (Age 21.) Refers to H. Cross, J. J. Doland, M. L. Enger, W. C. Huntington.

HERMAN, DONALD EUGENE, Chicago Heights, Ill. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

HOF, CHARLES DANIEL, Rapid City, S.Dak. (Age 24.) Refers to A. A. Chenoweth, E. D. Dake.

HOLDERBAUM, GEORGE ALBERT, Columbia City, Ind. (Age 24.) Refers to C. A. Ellis, R. B. Wiley.

HOLLOWAY, JOHN CARRINGTON, JR., Columbia, Mo. (Age 20.) Refers to R. B. B. Moorman, H. K. Rubey.

HORNE, CLEVELAND REID, JR., Gainesville, Fla. (Age 20.) Refers to R. M. Johnson, T. M. Lowe, P. L. Reed.

HOWER, NATHAN RALPH, Tuscaloosa, Ala. (Age 21.) Refers to G. J. Davis, Jr., D. C. A. Du-Plantier, J. S. Leister, E. E. Micheals.

IPSEN, MOGENS, Rockford, Ill. (Age 46.) Cons. Engr., Rockford, Ill.; also Dist. Director for Dist. No. 1, WPA, State of Illinois. Refers to A. J. Boase, G. F. Burch, L. H. Corning, T. Germundsson, C. B. Morgan, H. E. Wessman.

IRVINE, JOHN MCILRATH, Philadelphia, Pa. (Age 41.) Res. Engr., and Asst. to Pres., Albright & Friel, Inc. Refers to H. M. Chapin, J. G. Gruss, W. E. R. Irwin, C. F. Mebus, E. L. Rimbault, H. C. Seward, M. A. Webster.

ISTO, REYNOLD EDWARD, Newell, S. Dak. (Age 22.) Refers to A. A. Chenoweth. E. D. Dake.

JACOBY, HURLBUT SAYLOR, Pittsburgh, Pa. (Age 22.) Salesman, Standard San. Mfg. Co. Refers to J. E. Perry, R. Y. Thatcher.

JEPPESEN, NORMAN LUTZ, Joliet, Ill. (Age 22.) Refers to J. J. Doland, T. C. Shedd.

JOHNSON, MAYNARD DOUGLAS, South Bend, Ind. (Age 23.) Refers to C. A. Ellis, R. B. Wiley.

JOHNSON, WILLIAM MARTIN, Lynchburg, Va. (Age 32.) Engr. and Associate of firm, Wiley & Wilson, Cons. Engrs. Refers to R. B. H. Begg, R. W. B. Hart, M. D. Knight, Jr., R. Messer, F. J. Sette, H. G. Shirley, R. F. Wagner.

JONES, ALBERT BARNETT, Duluth, Minn. (Age 48.) Major, acting as Dist. Engr., Duluth Dist., Corps of Engrs., U. S. Army. Refers to O. D. Dales, L. L. Davis, H. Deakyne, W. Gerig, N. R. Gibson, T. H. Jackson, E. W. Lane, E. M. Markham, G. B. Pillsbury, P. S. Reinecke, M. C. Tyler.

JONES, SAMUEL LEARY, Blacksburg, Va. (Age 22.) Refers to R. B. H. Begg, F. J. Sette.

JUSTICE, FREDERICK EMERSON, Bloomingdale, N.J. (Age 36.) Tech. Foreman, road construction, Forestry Dept., CCC Camp S54, Butler, N.J. Refers to F. L. Castleman, L. D. Draper, F. D. Hutchinson, C. E. Pett, S. Shaw, A. Weymouth.

KAHL, WILLIAM GROVER, Kansas City, Mo. (Age 21.) Refers to H. Cross, T. C. Shedd.

KEENAN, HOWARD UNDERHILL, West Lafayette, Ind. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

KEITH, ARTHUR WRIGHT, Urbana, Ill. (Age 29.) Refers to W. C. Huntington, G. W. Pickels.

KIBBEY, HAL PIERCE, Kansas City, Mo. (Age 22.) Refers to H. Cross, T. C. Shedd.

KING, KARL KENNETH, Pekin, Ill. (Age 22.) Refers to J. J. Doland, W. H. Rayner.

KIRK, RIBELIN GAREY, Austin, Tex. (Age 22.) With Texas Highway Dept. Refers to J. T. L. McNew, J. J. Richey.

KIRKMAN, REYMOND FAUCHE, West Lafayette, Ind. (Age 22.) Refers to C. A. Ellis, H. S. Morse, R. B. Wiley.

KUHL, LEWIS CHARLES, JR., Rahway, N.J. (Age 35.) Structural Designer and Checker, Eng. Dept., Turner Constr. Co., New York City. Refers to E. K. Abberley, R. W. Boyd, H. G. Hauck, H. N. Lendall, H. T. Noyes, J. P. H. Perry, A. C. Tozzer.

KUNZER, PAUL JOSEPH, Chicago, Ill. (Age 22.) Refers to J. S. Crandell, J. J. Doland.

LAMSON, WILLIAM DEANE, Brooklyn, N.Y. (Age 23.) Refers to F. W. Garran, W. P. Kimball.

LEISINGER, LEWIS MARTIN, New York City. (Age 28.) Partner with A. H. Leisinger, Bldr. & Gen. Contr. Refers to E. N. Burrows, C. Crandall, H. N. Ogden, J. E. Perry, F. J. Spry, P. H. Underwood, L. C. Urquhart.

LIEBERMAN, HARRY ALVIN, Champaign, Ill. (Age 21.) Refers to J. S. Crandell, T. C. Shedd.

LINSKY, DAVID JOSEPH, Brooklyn, N.Y. (Age 28.) Refers to F. E. Foss, G. Morrison, M. H. Van Buren.

LINTON, GEORGE EDGAR, Bonneville, Ore. (Age 33.) Asst. Engr., U. S. Engr. Office, acting as Prin. Asst. to Field Office Engr., Bonneville Project. Refers to A. Bauer, G. E. Goodwin, C. A. Mockmore, H. A. Rands, F. C. Schubert, O. E. Stanley, B. E. Torpen.

LOUIS, LEO, Jr., Piqua, Ohio. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

MACCHI, ANSELMO JOHN, Hartford, Conn. (Age 23.) Refers to C. Derleth, Jr., C. T. Wiskocil.

MCDONALD, MURRAY, Vancouver, B.C. (Age 28.) Refers to A. H. Finlay, J. R. Grant.

MCKEE, JACK EDWARD, Pittsburgh, Pa. (Age 28.) Refers to C. G. Dunnells, F. J. Evans, F. M. McCullough, C. B. Stanton, H. A. Thomas.

MCNEIL, WILBUR LLOYD, Mason City, Ill. (Age 23.) Refers to J. J. Doland, J. Vawter.

MAHON, ROSS L'ESTRANGE, Berkeley, Calif. (Age 46.) Sales Engr., Soule Steel Co., San Francisco, Calif. Refers to W. Dreyer, J. D. Galloway, W. L. Huber, E. C. Hutchinson, W. E. Jessup, W. H. Kirkbride, A. H. Markwart.

MALEK, JOSEPH STANLEY, Manchester, Conn. (Age 21.) Refers to G. J. Davis, Jr., J. S. Leister.

MARRONE, ADOLPH ALFRED, Mt. Vernon, N.Y. (Age 23.) Refers to R. C. Brumfield, F. E. Foss, G. Morrison.

MASON, HARRY SHATTUCK, JR., Azusa, Calif. (Age 29.) Chf. of Party, San Gabriel Dam No. 1, Los Angeles County Flood Control Dist. Refers to P. Baumann, K. J. Harrison, R. R. Martel, C. L. Randolph, R. D. Reeve, F. Thomas.

MAUTZ, FERDINAND FRANCIS, Berkeley, Calif. (Age 21.) Refers to B. A. Etcheverry, S. T. Harding, B. Jameyson, C. T. Wiskocil.

MEYER RICHARD DAVIS, Fort Belvoir, Va. (Age 24.) First Lieut., Corps of Engrs., U. S. Army. Refers to C. Derleth, Jr., B. A. Etcheverry, S. T. Harding, B. Jameyson, M. P. O'Brien, C. T. Wiskocil.

MOLONY, WALTER EVERETT, Elmsford, N.Y. (Age 30.) Refers to A. Alexander, D. W. Carmichael, L. V. Carpenter, F. S. Childs, R. M. Genthon, T. R. Lawson, T. Saville.

MORRA, THOMAS ANTHONY, Astoria, N.Y. (Age 25.) Senior Draftsman and Asst. Engr. of

Constr., Park Dept., Queens, N.Y. Refers to R. C. Brumfield, F. E. Foss.

Morgan, Newlin Dolbey, Jr., Urbana, Ill. (Age 21.) Refers to H. Cross, J. J. Doland, W. C. Huntington.

Morrison, George Ian, Spokane, Wash. (Age 29.) Associated with his father on layout and construction of office buildings. Refers to B. J. Lambert, F. T. Mavis.

Morse, Robert Marston, East Cleveland, Ohio. (Age 22.) Refers to F. W. Garran, W. P. Kimball.

Nash, George Arthur, Eugene, Ore. (Age 21.) Refers to F. Merryfield, C. A. Mockmore.

Nelsen, La Vern James, Hastings, Nebr. (Age 26.) Designer, Hydr. Design Dept., The Central Nebraska Public Power & Irrigation Dist. Refers to H. A. Foster, P. F. Keim, J. Sorkin, C. E. Spellman, R. A. Sutherland.

Northrup, Milton George, Los Angeles, Calif. (Age 23.) Refers to R. M. Fox, D. M. Wilson.

O'Laughlin, James Francis, Moorhead, Minn. (Age 21.) Refers to H. M. Fitch, W. E. Smith.

Orhon, Ekrem, Urbana, Ill. (Age 24.) Refers to J. S. Crandell, H. Cross.

Owen, William Henry, Rolla, Mo. (Age 37.) Res. Engr. Inspector, Inspection Div., U. S. FEA of PW. Refers to T. R. Agg, A. W. Consoer, G. O. Consoer, H. S. Miller, G. S. Russell.

Palmer, Vincent Allen, Turlock, Calif. (Age 23.) Refers to C. G. Hyde, B. Jameyson, C. T. Wiskocil.

Parlett, John Garland, Boise, Idaho. (Age 24.) Asst. San. Engr., State of Idaho. Refers to E. L. Grant, S. B. Morris, C. Moser, L. B. Reynolds, E. C. Thomas.

Patterson, Hubert Fulton, Oxford, Miss. (Age 22.) Refers to A. B. Hargis, R. B. B. Moorman.

Peller, Phillip Allen, Maywood, Ill. (Age 23.) Refers to N. D. Morgan, C. E. Palmer.

Pendleton, James Benjamin, Topeka, Kans. (Age 37.) Structural Designer, Kansas State Highway Comm., Bridge Design Dept. Refers to F. W. Epps, A. T. Granger, L. Grover, R. B. Houston, C. S. Jones, H. C. Tammen, J. M. Waller.

Post, Ludwig Karl, Portland, Ore. (Age 46.) With City of Portland (Ore.) on WPA work. Refers to G. W. Buck, R. G. Dieck, J. G. Kelley, J. H. Lewis, B. S. Morrow, J. H. Polhemus.

Rivetz, Martin, Brooklyn, N.Y. (Age 25.) Refers to F. E. Foss, M. F. Freund, G. Morrison.

Robinson, Meade Morrison, Louisville, Ky. (Age 23.) Refers to N. D. Morgan, C. E. Palmer.

Roelke, Paul Lewis, Teegarden, Ind. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

Ruckman, Joseph, Bronx, N.Y. (Age 24.) Refers to R. C. Brumfield, F. E. Foss, M. H. Van Buren.

St. John, Lee Harvey, Gooding, Idaho. (Age 41.) In private practice. Refers to S. Baker, R. M. Buck, T. C. Goyn, J. E. Hayes, E. C. Panton, J. B. Stocking, W. Ward.

Schmidt, Frank John, Ridgewood, N.Y. (Age 23.) Refers to F. E. Foss, G. Morrison, J. P. J. Williams.

Schuler, Axel, Philadelphia, Pa. (Age 36.) Chf. Engr. and Pres., Gilmour Steel Products Co., Inc. Refers to L. H. Doane, J. J. Grelis, Jr., H. B. Miller, C. H. Schaefer, C. H. Schwertner, F. W. Schwiers, Jr., I. S. Towsley.

Sheinwald, Benjamin Schellenberg, Brookline, Mass. (Age 23.) Refers to C. A. Ellis, R. B. Wiley.

Shirley, John Phelan, Jr., Los Angeles, Calif. (Age 30.) Engr., Gunther & Shirley Co. Refers to J. A. Beemer, R. C. Booth, R. M. Conner, A. S. Cutler, C. P. Dunn, J. L. Hershey, W. K. McIlyar, R. M. Merriman.

Siess, Chester Paul, Alexandria, La. (Age 20.) Party Chf., Louisiana Highway Comm. Refers to G. N. Cox, N. E. Lant, L. J. Muse, B. W. Pegues, F. F. Pillet.

Simpson, John Temple, Denver, Colo. (Age 22.) Jun. Engr., Hydr. Investigations Sec. Bureau of Reclamation. Refers to C. T. Johnston, H. W. King, C. O. Wisler.

Smith, Adrian Woodrow, Salt Lake City, Utah. (Age 23.) Refers to T. C. Adams, R. B. Ketchum, F. H. Richardson, K. C. Wright.

Smith, Ralph Albert, Muskegon, Mich. (Age 32.) Res. Engr. on water-works and sewerage improvements, Consoer, Townsend & Quinlan. Refers to A. W. Consoer, G. O. Consoer, J. A. Fulkman, W. Harwood, B. H. Platt, G. A. Quinlan, U. F. Turpin.

Solomekin, Walter John, LaPorte, Ind. (Age 25.) Inspector on construction, State Highway Comm. of Indiana. Refers to C. A. Ellis, R. B. Wiley.

Sommer, William Nelson, Springfield, Ill. (Age 30.) Jun. Highway Engr., Illinois Div. of Highways. Refers to G. F. Burch, H. E. Eckles, P. Z. Michener, C. E. Morgan, H. K. Rubey, W. N. Schroeder, L. T. Wyly.

Spencer, Gordon Selby, Springfield, Mass. (Age 23.) Adams & Ruxton Constr. Co. Refers to F. W. Garran, W. P. Kimball.

Starke, Dick Dryden, Springfield, Ill. (Age 38.) Asst. Highway Engr., Grade Separations, Illinois Div. of Highways. Refers to G. H. Baker, G. F. Burch, E. D. Dryfoose, P. Z. Michener, C. E. Morgan, L. E. Philbrook, H. E. Struck.

Stone, Franklin Webb, West Lafayette, Ind. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

Stoyke, Ludwig Theodore, Chicago, Ill. (Age 22.) Refers to J. J. Doland, W. A. Oliver, M. Suter.

Sucre, Francisco Jose, Caracas, Venezuela. (Age 40.) Director, Bureau of Design, Ministry of Public Works. Refers to E. Aguerrevere, J. J. Collins, R. E. Colvin, V. de Chelminski, J. M. Ibarra Cerezo, J. R. Stubbins, M. M. Upson.

Tatham, Norman John, Glendale, Calif. (Age 23.) Chainman, Southern California Gas Co. Refers to J. W. Cleland, B. A. Etcheverry, S. T. Harding.

Taylor, Guy Harvey, Portland, Ore. (Age 21.) Refers to F. Merryfield, C. A. Mockmore.

Taylor, James Donald, Springfield, Ill. (Age 27.) Refers to E. E. Bauer, J. J. Doland.

Terrill, Jack William, Jefferson City, Mo. (Age 22.) With Missouri State Highway Dept. Refers to R. B. B. Moorman, H. K. Rubey.

Thompson, Miles Howlett, Los Angeles, Calif. (Age 24.) Inspector, Hydraulic Design, Rivers, Harbors and Waterways Constr., U. S. Engr. Office. Refers to E. C. LaRue, H. K. Rubey, H. K. Shane.

Tomlinson, Frederick Byron, Bridgeport, Conn. (Age 22.) Refers to F. W. Garran, W. P. Kimball.

Tovell, Clarence Eugene, Baltimore, Md. (Age 33.) Vice-Pres. and Mgr., G. Walter Tovell, Inc., Bldrs. and Contrs. Refers to P. G. Crout, J. H. Gregory, A. H. Krone, G. C. Saunders, J. T. Thompson.

Triggs, James Frederick, Pittsburgh, Pa. (Age 29.) Asst. Dist. Engr., Dist. 11, Pennsylvania Highway Dept. Refers to U. N. Arthur, L. P. Blum, F. Burroughs, R. H. Helick, J. C. Jordan, H. P. McKown, N. S. Sprague.

Trook, Mark Monroe, Converse, Ind. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

Utterback, Thomas Eugene, Gallup, N.Mex. (Age 23.) Asst. Engr. Aide and Research Asst., U. S. Soil Conservation Service. Refers to E. L. Barrows, P. S. Fox, B. Johnson, H. C. Neuffer, A. N. Thompson.

Voss, Frederick Joseph, Fostoria, Ohio. (Age 22.) Refers to C. A. Ellis, R. B. Wiley.

Warren, Frank Kaile, Jr., Hollis, N.Y. (Age 25.) With F. & M. Schaefer Brewing Co., Brooklyn, N.Y. Refers to H. N. Ogden, J. E. Perry, P. H. Underwood, L. C. Urquhart.

Westman, John Franklyn, Jr., New York City. (Age 24.) Refers to R. C. Brumfield, F. E. Foss, G. Morrison, M. H. Van Buren.

Wetzel, Charles Maynard, Hegins, Pa. (Age 20.) Refers to G. J. Davis, Jr., J. S. Leister.

Wheeler, Frank Wirtly, Raleigh, N.C. (Age 29.) Senior Draftsman, State Highway and Public Works Comm. Refers to R. B. H. Begg, O. B. Bestor, C. W. Johns, G. E. Large, C. Miller, C. T. Morris, J. R. Shank.

Willis, John Fink, Hartford, Conn. (Age 47.) Engr. of Bridge Design, Connecticut State Highway Dept. Refers to A. A. N. Fenoglio, G. E. Hamlin, J. T. Henderson, H. C. Orr, W. H. Sharp, R. S. Treat, J. B. Wright.

Wilson, Harold Walter, Kewanna, Ind. (Age 23.) Refers to C. A. Ellis, R. B. Wiley.

Wilson, John Hanly, Chicago, Ill. (Age 29.) Office Engr., Northern Bridge Co. Refers to W. R. Britton, J. T. Hallett, F. Kellam, W. A. Knapp, J. S. Neibert, A. M. Turner, A. M. Westenhoff.

Wright, Wells Duncan, Balboa Heights, Canal Zone. (Age 37.) Chf. Inspector, with Sec. of Office Engr., The Panama Canal. Refers to M. R. Alexander, E. M. Browder, Jr., A. L. Hertz, R. C. Jones, L. B. Moore.

Wyller, Christian Frederik, Juneau, Alaska. (Age 34.) Asst. Highway Engr., Bureau of Public Roads, Alaska. Refers to H. Omsted, R. H. Stock, L. W. Turoff, M. D. Williams, C. R. Wright.

Youngquist, Ruben Clifford, Los Angeles, Calif. (Age 39.) Draftsman, in charge of Hydr. Laboratory, Dept. of Water and Power. Refers to W. W. Hurlbut, J. E. Jones, D. A. Lane, S. B. S. Nelson, R. R. Proctor, H. A. Van Norman, W. W. Wyckoff.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

Crocker, Foster Baldwin, Assoc. M., Fayetteville, N.Y. (Elected Junior June 30, 1911; Assoc. M. Jan. 7, 1913.) (Age 52.) Associate Civ. Engr., Dept. of Public Works, New York State. Refers to H. B. Brewster, W. W. Cronin, E. D. Hendricks, G. D. Holmes, D. B. LaDu, D. R. Lee, L. Mitchell.

Currie, Frank Shields, Assoc. M., San Bernardino, Calif. (Elected Oct. 21, 1924.) (Age 41.) With Currie Eng. Co. Refers to C. H. Currie, C. G. Gillespie, R. F. Goudey, G. S. Hinckley, W. T. Knowlton, R. W. Lawton.

Grover, LaMotte, Assoc. M., Topeka, Kans. (Elected Oct. 30, 1933.) (Age 35.) Office Bridge Engr., Dept. of Design, State Highway Comm. of Kansas. Refers to W. V. Buck, L. E. Conrad, O. J. Eidmann, F. W. Epps, C. S. Jones, J. I. Quinn, C. H. Scholer.

Hudson, Franklin, Assoc. M., Roselle, N.J. (Elected Junior Oct. 2, 1922; Assoc. M. Aug. 29, 1927.) (Age 35.) Cons. Engr. with E. J. Grassmann, Elizabeth, N.J. Refers to W. L. Benham, E. H. Burroughs, Jr., T. E. Collins, C. V. Davis, A. L. Mullergren, H. M. Nabstedt, S. F. Newkirk, Jr., H. W. Nighswonger, L. A. Robb, F. A. Russell, C. T. Schwarze, S. W. Stewart.

Long, George Vilas, Assoc. M., Coshocton, Ohio. (Elected Aug. 29, 1927.) (Age 44.) Asst. Field Engr. in charge of Coshocton County, WPA in Ohio, Dist. No. 4. Refers to

E. D. Barstow, C. T. Cavan, F. H. Eno, C. T. Morris, C. E. Sherman, F. E. Swineford, R. N. Waid.

MOORE, JAMES GATES, Assoc. M., Madison, Fla. (Elected Oct. 14, 1919.) (Age 53.) Director of Operations, Cherry Lake Farms (Govt. sponsored rural-industrial community). Refers to N. W. Green, J. H. Hession, T. A. Lucy, H. D. Mendenhall, A. F. Perry, Jr., J. H. Pratt, N. H. Sturdy.

SCHOLER, CHARLES HENRY, Assoc. M., Manhattan, Kans. (Elected Dec. 15, 1924.) (Age 45.) Prof. and Head of Dept. of Applied Mechanics, Kansas State Coll.; also Engr. of Tests., Kansas Highway Comm. Refers to W. V. Buck, H. F. Clemmer, L. B. Conrad, R. W. Crum, R. E. Davis, F. F. Frazier.

VAN BUREN, MILES HERBERT, Assoc. M., Brooklyn, N.Y. (Elected Junior Feb. 25, 1924; Assoc. M. Oct. 1, 1926.) (Age 37.) Instructor in Civ. Eng., Cooper Union, also with Barney-Ahlers Constr. Co., New York City. Refers to J. R. Aikenhead, W. J. Barney, W. E. Brown, R. C. Brumfield, F. E. Foss, B. Schwerin.

FROM THE GRADE OF JUNIOR

ADAMS, FRANCIS LEE, Jun., Washington, D.C. (Elected Oct. 14, 1929.) (Age 30.) Engr., National Power Survey, Federal Power Comm. Refers to R. W. Burpee, J. D. Fitch, O. L. Hooper, W. H. McAlpine, F. S. Warner.

BERGLE, CHARLES KALMAN, Jun., Bayonne, N.J. (Elected Jan. 16, 1928.) (Age 32.) Supt., B. Vezzetti & Son, Inc., Hoboken, N.J. Refers to C. I. Bausher, M. Birman, C. T. Morris, J. R. Shank, C. E. Sherman.

DOW, MELVIN CHARLES, Jun., Newburgh, N.Y. (Elected Oct. 1, 1926.) (Age 32.) Asst. Engr., New York Trap Rock Corporation. Refers to W. E. Cowan, M. B. Crosby, A. T. Goldbeck, E. L. Heidenreich, Jr., C. MacDonald, J. W. Reid, E. S. Wright.

FREEL, WILFRED ISAAC, Jun., West Lafayette, Ind. (Elected Oct. 1, 1926.) (Age 33.) Instructor in Civ. Eng. in Materials Testing Laboratory and Hydraulic Laboratory, Purdue Univ., Lafayette, Ind. Refers to C. A. Ellis, E. L. Eriksen, W. K. Hatt, W. J. Henderson, S. C. Hollister, W. E. Howland, G. E. Lommel, J. H. Matthews, G. P. Springer, R. B. Wiley.

GRIDLEY, HORACE VELSEY, Jun., Pasadena, Calif. (Elected Dec. 15, 1924.) (Age 32.) Sales Engr., Garlinghouse Bros. Refers to R. L. Anderson, A. F. Garlinghouse, L. H. Garlinghouse, R. A. Hill, E. C. Macy, S. B. Morris, A. Taylor, F. Thomas, V. Wood.

GUTIERREZ SALINAS, JORGE BRAULIO, Jun., Hannover, Herrenhausen, Germany. (Elected June 9, 1930.) (Age 32.) Inspector Engr. for Argentine Govt. on Louis Eilers Works, Hannover, Germany. Refers to A. Acevedo, J. A. Valle. (Applies in accordance with Sec. 1, Art. I, of the By-Laws.)

HULL, WILLIAM JANNEY, Jun., Honolulu, Hawaii. (Elected Jan. 26, 1931.) (Age 29.) Engr., Board of Water Supply. Refers to J. F. Kunesh, G. K. Larrison, F. Ohrt, C. M. Saville, W. L. Voorduin.

LARGE, JOSEPH G., Jun., Seattle, Wash. (Elected Oct. 1, 1926.) (Age 32.) With Isaacson Iron Works. Refers to G. E. Hawthorn, R. P. Hutchinson, C. C. More, R. M. Murray, F. H. Rhodes, Jr., V. K. Schegolkov, R. G. Tyler.

MCKEON, FRANCIS DANIEL, Jun., Syracuse, N.Y. (Elected Oct. 1, 1926.) (Age 32.) Asst. Engr., New York State Highway Dept. Refers to E. F. Berry, J. W. Beardsley, C. S. Herrick, G. D. Holmes, L. Mitchell, N. F. Pitts, Jr., F. W. Stephens.

SPEER, PAUL RUDOLPH, Jun., Albany, N.Y. (Elected June 10, 1935.) (Age 32.) Associate Engr., Water Resources Branch, U. S. Geological Survey. Refers to E. D. Burchard, N. C. Grover, A. W. Harrington, A. H. Horton, J. C. Hoyt, H. Johnson, J. W. Mangan, R. O'Donnell, C. G. Paulsen, E. D. Walker, D. S. Wallace.

STRICKLAND, RICHARD PORTER, Jun., Washington, D.C. (Elected Nov. 14, 1927.) (Age 30.) Asst. Civ. Engr., Resettlement Administration, Div. of Suburban Resettlement. Refers to H. W. Bressler, H. B. Bursley, E. A. Gracy, W. Haydock, W. N. Olewiler, E. D. Walker.

WHITE, HAROLD LEROY, Jun., Ontario, Calif. (Elected July 16, 1928.) (Age 32.) Constr. Engr., American Concrete & Steel Pipe Co., Rochester, Calif. Refers to H. R. Bolton, R. B. Diemer, A. L. Gram, D. S. Hays, J. Hinds, L. B. Reynolds, K. Q. Volk.

WILLIAMS, GORDON RYERSON, Jun., New York City. (Elected Oct. 14, 1929.) (Age 30.) Asst. Hydr. Engr., Water Resources Branch, U. S. Geological Survey, Washington, D.C.; also director of hydrologic research project at New York Univ. Refers to R. W. Davenport, N. C. Grover, C. S. Jarvis, H. B. Kinnison, C. G. Paulsen, T. Saville.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1936 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CIVIL ENGINEER; Jun. Am. Soc. C.E.; single; B.S.C.E., 1930. Experienced in building, oil refinery, and railroad construction—chief of party; 2 1/2 years in planning and time-study work; after graduation took course in cost accounting. Wants position in construction (planning and costs) or with insurance company as inspector. C-8602.

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; 29; single; graduate civil engineer, New York University, 1930; 5 years with contractor on subway and vehicular tunnels; field engineer and assistant to chief engineer on subsurface construction (compressed air) and all hydrographic dredging, surveying, etc. Desires work with general contractor on new construction. Employed; available in one month. D-1921.

CONSTRUCTION ENGINEER AND SUPERINTENDENT; M. Am. Soc. C.E.; member Canadian Institute of Civil Engineers; professional engineer and land surveyor, New York and New Jersey; considerable experience on construction of tunnels—compressed air, vehicular, and rock; subways, sewerage and water systems, reservoirs, and heavy construction of all kinds. Salary depends on location, etc. D-5015.

DESIGN

CIVIL AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 37; married; graduate of Michigan State College; New York license; 8 years experience in building and structural design; 3 years varied experience, including aerial-photo compilation location immaterial. C-7048.

CIVIL ENGINEER; M. Am. Soc. C.E.; licensed professional engineer, New York and New Jersey; 15 years with one company, in charge of design and details. All types of railroad structures, steel and reinforced concrete; office and field; 15 years varied experience on important construction jobs. Large bridges, industrial buildings, estimates, design, rapid transit systems. Difficult foundations, rigid-frame structures. C-5109.

EXECUTIVE

MUNICIPAL ENGINEER AND CITY MANAGER; Assoc. M. Am. Soc. C.E.; age 44; married; graduate; 20 years experience; Ohio and Michigan registration; 4 years as city engineer—building, planning and zoning; 1 year federal relief work. Economical administration. C-5640.

PROMOTION AND CONSTRUCTION; Assoc. M. Am. Soc. C.E.; New York state license; graduate of Rensselaer Polytechnic Institute; married; 45; 13 years as construction foreman and field engineer in industrial design; 12 years as fire-protection, trade extension, building-code, and legislation expert—consultant and executive manager. Competent speaker, versatile, with good address; seeks responsible position, with New York headquarters, on difficult, productive work. B-3727.

SALES ENGINEER; M. Am. Soc. C.E.; registered engineer, Pennsylvania; has followed steel construction and general contracting for over 25 years and is thoroughly qualified and experienced in the various branches of engineering, sales, operations, and construction. Available immediately. C-5095.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 30; married. C.E., University Maryland; 1 1/2 years survey with Water and Sewer Commission; 2 years building construction including foundation piling and superstructure; 1 year hydraulic dredging, subaqueous surveys, test borings, bids and estimates; 1 year drafting and design of buildings. Capable of handling men. D-4983.

HYDRAULIC AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; age 33; married; graduate; 12 years experience on investigation, surveys, design, estimate, construction, and maintenance of large and small hydro-electric developments, domestic and foreign. Desires connection with power company. Available on reasonable notice. C-3752.

JUNIOR

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; B.S.C.E., 1933; 3 years varied experience, including survey, design, and construction of roads and highways. Executed research on bituminous pavings. Built Amesite plant. Also interested in foreign service. Location immaterial. Now available. D-4740.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; single. Graduate of Purdue University with highest honors; 6 years diversified experience as large structural steel fabricator. Experienced in shop fabrication, structural detailing, field erection of bridges and buildings, cost accounting, design, estimating. Capable of handling men. Desires position with active construction or engineering organization offering opportunity for advancement. Location immaterial. D-2655.